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Feeling Needed: Effects of Generativity on Health and Well-Being in Older Women

A dissertation submitted in partial satisfaction of the  
requirements for the degree Doctor of Philosophy  
in Psychology

by

Mona Moieni

2017



## ABSTRACT OF THE DISSERTATION

Feeling Needed: Effects of Generativity on Health and Well-Being in Older Women

by

Mona Moieni

Doctor of Philosophy in Psychology

University of California, Los Angeles 2017

Professor Naomi Ilana Eisenberger, Chair

Generativity—concern and care for the well-being of others, particularly younger generations—is an important component of successful aging. However, generativity has been understudied in older adults, and despite the potential for generativity interventions to positively impact health and well-being, this area of investigation has been especially lacking. The goal of this dissertation was to address this gap in the literature by designing and testing the effect of a novel writing-based generativity intervention in a sample of older women (aged 60 and over,  $n=73$ ). Participants in this study were randomly assigned to complete six weeks of writing either intended to increase feelings of generativity by sharing experiences and advice with others (generativity condition) or intended to be neutral, descriptive writing (control condition). Pre- and post-intervention, participants completed self-report assessments of multiple domains of health, including social well-being, mental health, and physical health. Additionally, blood

samples were collected to assess circulating levels of pro-inflammatory cytokines and pro-inflammatory gene expression.

To begin, Paper 1 describes the main effects of this novel writing-based generativity intervention on health and well-being. The generativity intervention led to improvements across multiple measures, including increases in participation in social activities, decreases in psychological distress, more positive expectations regarding aging in the physical health domain, and decreases in inflammatory biology as assessed by gene expression and bioinformatic analyses.

Paper 2 describes the effect of another psychosocial factor, expectations regarding aging, in the context of this generativity intervention. Beliefs about aging can influence well-being, and this paper tested whether expectations regarding aging moderate the impact of a generativity intervention on social outcomes. As hypothesized, results indicated that participants in the generativity condition with more positive expectations regarding mental health reported greater perceptions of social support and lower feelings of loneliness post-intervention.

Together, the results of these papers contribute to our understanding of generativity and aging, which is an important but understudied area of research. They also emphasize the importance of studying psychosocial factors such as generativity and beliefs about aging and suggest that a writing-based generativity intervention may be impactful in improving health and well-being in older adults.

The dissertation of Mona Moieni is approved.

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2017

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## VITA

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### Publications

1. **Moieni, M.** & Eisenberger, N.I. Social isolation and health. (in press). To appear in: K. Sweeny & M. Robbins (Eds). *The Wiley Encyclopedia of Health Psychology*.
2. Eisenberger, N.I., **Moieni, M.**, Inagaki, T.K., Muscatell, K.A., & Irwin, M.R. (2017). In sickness and in health: The co-regulation of inflammation and social behavior. *Neuropsychopharmacology Reviews*, 42(1), 242-253.

3. Inagaki, T.K., Muscatell, K.A., **Moieni, M.**, Dutcher, J., Jevtic, I., Irwin, M.R., & Eisenberger, N.I. (2016). Yearning for connection? Loneliness is associated with increased ventral striatum activity to close others. *Social Cognitive and Affective Neuroscience*, 11(7): 1096-1101.
4. Muscatell, K.A., **Moieni, M.**, Inagaki, T.K., Dutcher, J.D., Jevtic, I., Breen, E.C., Irwin, M.R., & Eisenberger, N.I. (2016). Inflammation enhances neural sensitivity to negative and positive social feedback. *Brain, Behavior, and Immunity*, 57: 21-29.
5. Inagaki, T.K., Irwin, M.R., **Moieni, M.**, Jevtic, I., & Eisenberger, N.I. (2016). A pilot study examining physical and social warmth: Higher (non-febrile) oral temperature is associated with greater feelings of social connection. *PLoS ONE* 11(6):e0156873.
6. **Moieni, M.** & Eisenberger, N.I. Neural correlates of social pain. (2016). E. Harmon-Jones & M. Inzlicht (Eds). *Social Neuroscience: Biological Approaches to Social Psychology*, Psychology Press.
7. **Moieni, M.**, Irwin, M.R., Jevtic, I., Breen, E.C., Arevalo, J.M.G., Ma, J., Cole, S.W., & Eisenberger, N.I. (2015). Trait sensitivity to social disconnection enhances pro-inflammatory responses to a randomized controlled trial of endotoxin. *Psychoneuroendocrinology*, 62: 336-342.
8. **Moieni, M.**, Irwin, M.R., Jevtic, I., Breen, E.C., & Eisenberger, N.I. (2015). Inflammation impairs social cognitive processing: a randomized controlled trial of endotoxin. *Brain, Behavior, and Immunity*, 48: 132-138.
9. **Moieni, M.**, Irwin, M.R., Jevtic, I., Olmstead, R., Breen, E.C., & Eisenberger, N.I. (2015). Sex differences in depressive and socioemotional responses to an inflammatory challenge: Implications for sex differences in depression. *Neuropsychopharmacology*, 40(7): 1709-1716.
10. Inagaki, T.K., Muscatell, K.A., Irwin, M.R., **Moieni, M.**, Dutcher, J.M., Jevtic, I., Breen, E.C., & Eisenberger, N.I. (2015). The role of the ventral striatum in inflammatory-induced approach toward support figures. *Brain, Behavior, and Immunity*, 44: 247-252.
11. Evans, S., **Moieni, M.**, Lung, K., Tsao, J.C., Sternlieb, B., Taylor, M., & Zeltzer, L.K. (2013). Impact of Iyengar yoga on quality of life in young women with rheumatoid arthritis. *The Clinical Journal of Pain*, 29(11):988-997.
12. Evans, S., **Moieni, M.**, Tsao, J.C., Sternlieb, B., & Zeltzer, L.K. (2012). Yoga for youth in chronic pain: The pediatric pain program model. *Holistic Nursing Practice*, 26(5):262-271.
13. Evans, S., **Moieni, M.**, Subramanian, S.K., Tsao, J.C., Sternlieb B., & Zeltzer, L.K. (2011). "Now I see a brighter day": expectations and perceived benefits of an Iyengar yoga intervention for young patients with rheumatoid arthritis. *Journal of Yoga and Physical Therapy*, 1(101):101.
14. Evans, S., **Moieni, M.**, Taub, R., Subramanian, S.K., Tsao, J.C., Sternlieb B., & Zeltzer, L.K. (2010). Iyengar yoga for young adults with rheumatoid arthritis: results from a mixed methods pilot study. *Journal of Pain and Symptom Management*, 39(5):904-13.
15. Boykoff, N., **Moieni, M.**, & Subramanian, S.K. (2009). Confronting chemobrain: An in-depth look at survivors' reports of impact on work, social networks, and health care response. *Journal of Cancer Survivorship*, 3(4): 223-32.

## INTRODUCTION

“People want to share memories, pass on wisdoms and keepsakes, connect with loved ones, and to make some last contributions to the world. These moments are among life’s most important, for both the dying and those left behind.”

-Atul Gawande, surgeon, journalist, and author of *Being Mortal: Medicine and What Matters in the End*

By 2020, the number of adults aged 65 and older will outnumber the number of children aged 0-4 for the first time in human history (Population Reference Bureau, 2011). Given this unprecedented growth in the global population of older adults, investigating factors that may influence health outcomes in an aging population is crucial. Generativity, and its impacts on health and well-being in older adults, is one understudied area worthy of further investigation.

Psychologist Erik Erikson introduced the concept of generativity, describing it as care and concern for a younger generation (Erikson, 1964). Generativity is multi-faceted, involving concern and activity devoted to contributing to others and society, driven by internal desire and external expectations and opportunities (McAdams & De St Aubin, 1992). The desire to be generative can be motivated by a need to be useful to others or a “need to be needed” (McAdams & De St Aubin, 1992), as well as a desire to leave a legacy behind after death. Many different activities involving contributions to the well-being of others or society are relevant to generativity, such as parenting, volunteering, mentoring, community involvement, or scientific, political or artistic endeavors. Essentially, generativity “connects [adults] to other people, institutions, and even societal and global concerns that are deemed worthy of one’s care, investment, and contribution” (McAdams & de St Aubin, 1998).

Some empirical findings have also shed light on the importance of generativity and its related constructs for promoting health and well-being in older adults. For example, generativity has a positive impact on psychological well-being (An & Cooney, 2006). Older adults who feel more generative, or feel more socially useful, also have a decreased risk for morbidity and mortality (Gruenewald, Karlamangla, Greendale, Singer, & Seeman, 2007, 2009; Gruenewald, Liao, & Seeman, 2012). Despite the relevance of generativity for health and well-being in older adults, generativity has largely been overlooked in the aging literature (Schoklitsch & Baumann, 2012).

Thus, the purpose of this dissertation was to further the study of generativity in the context of health and aging. This was achieved by developing and testing the effects of a novel writing-based generativity intervention in older women. Various barriers such as greater prevalence of disability, less education, lower self-efficacy, and poverty may impede older women's pursuit of generative activities, suggesting that older women may be in particular need for generative opportunities (Carlson, Seeman, & Fried, 2000). In this study, older women aged 60 and over (n=73) were randomly assigned either to a 6-week generativity or control condition. In the generativity condition, participants were asked to share life experiences, advice, and wisdom which would ultimately be shared with middle-aged adults. In the control condition, participants completed neutral, descriptive writing which was not shared with others. Directly before and after the intervention, participants completed self-report measures of physical health, mental health, and social well-being. Blood samples were also taken pre- and post-intervention in order to assess inflammatory markers. Measures of inflammation specifically included: 1) circulating pro-inflammatory cytokines, as assessed by plasma levels of interleukin(IL)-6 and tumor necrosis factor (TNF)- $\alpha$  and 2) pro-inflammatory gene expression and bioinformatic

analyses. The results of this dissertation project are described in two papers, briefly outlined below.

*Paper 1: Effects of a Writing-Based Generativity Intervention in Older Women*

The first paper describes the effects of a writing-based generativity intervention on health and well-being outcomes in older women. Main effects of the intervention are examined in multiple domains, including social well-being (e.g., participation in social activities), mental health (e.g., psychological distress), physical health (e.g., pain, sleep), and inflammation (circulating levels of pro-inflammatory cytokines and pro-inflammatory gene expression).

*Paper 2: Generativity and Social Well-Being in Older Women: A Relationship Dependent on Expectations Regarding Aging*

In addition to generativity, beliefs and expectations regarding aging (e.g., believing that loneliness and depression are a normal part of aging) may contribute to well-being in older adults. As such, the second paper tests whether expectations regarding aging, specifically in the mental health domain, moderate the impact of a writing-based generativity intervention on social outcomes (i.e., perceptions of social support and feelings of loneliness).

*Overarching Goal*

Together, these two papers stemming from this dissertation project aim to better understand the relationship between generativity and health and well-being in older adults. Examining the effects of generativity, alone and in combination with other psychosocial factors such as expectations regarding aging, is an important, understudied topic of research in the aging literature. Furthermore, developing low-cost, low-intensity psychosocial interventions such as the one described in this dissertation may be an effective area of investigation in seeking to improve the health and well-being of an aging global community.



Paper 1:

Effects of a Writing-Based Generativity Intervention in Older Women

## **Abstract**

Generativity, or concern for and contribution to the well-being of younger generations, plays an important role in successful aging. The purpose of this study was to develop a novel writing-based intervention to increase feelings of generativity and test the effect of this intervention on health and well-being in a sample of older women. Participants in this study (n=73) were randomly assigned to a 6-week generativity (writing about life experiences and sharing advice with others) or control (neutral, descriptive writing) condition. Self-reported measures of health and well-being, as well as inflammation (plasma levels of pro-inflammatory cytokines IL-6 and TNF- $\alpha$ ; genome-wide transcriptional profiling), were assessed pre- and post-intervention. The generativity intervention led to improvements across multiple domains, including increases in participation in social activities, decreases in psychological distress, more positive expectations regarding aging in the physical health domain, and decreases in pro-inflammatory gene expression. Thus, this study provides preliminary evidence for the ability of this novel low-cost, low-effort intervention to positively impact health and well-being in older women.

## **Effects of a Writing-Based Generativity Intervention in Older Women**

The proportion of the world's population aged 65 and older is growing at a rate unparalleled in history (Population Reference Bureau, 2011), creating an urgent need to study factors relevant to health and well-being in older adults. Generativity, or feeling that one is contributing to others, particularly younger generations, is one such factor that appears to play a role in successful aging (Fisher, 1995). Indeed, feeling more generative is associated with greater psychological well-being, as well as better physical functioning and lower mortality (An & Cooney, 2006; Gruenewald, Liao, & Seeman, 2012), pointing to generativity as an important facet of health and well-being in older adults.

As further evidence for the importance of generativity for health and aging, components of generativity such as feeling more needed by and useful to others are also linked to lower disability and mortality in older adults (Gruenewald, Karlamangla, Greendale, Singer, & Seeman, 2007, 2009). Furthermore, engaging in productive activities, which could potentially lead to increases in feelings of generativity, is related to lower markers of inflammation in older adults (S. Kim & Ferraro, 2013). Given that inflammation increases as a function of aging (Ershler & Keller, 2000) and is also underlying many diseases of aging (e.g., cardiovascular disease, arthritis, cancer; Ferrucci et al., 1999), the impact of generativity on inflammation may be an important contributor to health outcomes in aging populations.

Despite the relevance of generativity for health and well-being in older adults, it has been noted that generativity is highly understudied in geriatric populations and deserving of further exploration (Schoklitsch & Baumann, 2012). One area that has been particularly overlooked is the development of interventions to experimentally increase feelings of generativity in older adults; much of the work on the links between generativity and health has been correlational.

Furthermore, given the relationships between generativity and positive health outcomes, such an intervention may lead to improvements in health and well-being.

The Baltimore Experience Corps Trial (EC), a volunteering intervention in which older adults teach children in elementary schools, provides some preliminary evidence for the impact of generativity interventions on health in older adults. The EC program, which involves intergenerational contact, increases feelings of generativity (Gruenewald et al., 2015), suggesting that generativity is a malleable construct which can be increased by an intervention. The program also leads to improvements in both psychological and physical health (Hong & Morrow-Howell, 2010), indicating the potential benefits of a generativity intervention.

Together, these findings suggest that generativity is an important factor for healthy aging, and that interventions which increase feelings of generativity, such as the EC program, can positively impact health and well-being. However, many older adults may have a desire to be more generative but may not have the physical ability or desire to commit to volunteering in this type of “high-intensity” program. Thus, an alternative generativity intervention which involves a lower level of physical exertion and time commitment (e.g., a brief writing-based intervention) may be more accessible to some older adults. But, to our knowledge, there have been no writing-based interventions aiming to increase feelings of generativity.

Thus, the aim of this study was to fill this gap in the literature by testing the first writing-based intervention aimed at increasing feelings of generativity. Participants in this study were randomly assigned to either a generativity or control condition, both of which involved writing once a week for six weeks. Directly pre- and post-intervention, participants completed self-report measures of generativity, social well-being, mental health, and physical symptoms and health.

Participants also had blood drawn to measure markers of inflammation pre- and post-intervention, making this the first study to examine the impact of generativity on inflammation. Circulating levels of inflammation and pro-inflammatory gene expression were both measured, providing multiple levels of analysis for inflammatory outcomes. Plasma levels of pro-inflammatory cytokines interleukin(IL)-6 and tumor necrosis factor (TNF)- $\alpha$  were measured as markers of circulating inflammation. To assess upstream sources of cytokine expression, gene expression profiling and bioinformatic analyses of gene expression data were conducted.

Given the literature linking generativity and positive health outcomes, we predicted that the generativity intervention would lead to improvements in self-report measures of health and well-being, as well as decreases in pro-inflammatory biology.

## **Methods**

### ***Participants and procedure***

#### ***Participants.***

Participants were recruited from multiple sources, including flyers posted in the Los Angeles community (e.g., libraries, senior centers), advertisements in local newspapers, mailers to participants in prior studies and patients from the UCLA Geriatrics Clinic who had consented to learn about future studies. Interested participants were screened for eligibility using a structured telephone interview. Inclusionary criteria included: 1) being a healthy female 60 years of age or older, 2) fluency in English, and 3) access to the Internet and a computer to complete the weekly study sessions.

Given that there are sex differences in generativity (e.g., women generally feel more obligated to assist social institutions and other people; Keyes & Ryff, 1998), generativity interventions may be differentially impactful on women than men. Because it has been proposed that older women may particularly benefit from new outlets to promote generative activity

(Carlson, Seeman, & Fried, 2000) and may have the most to gain from a generativity intervention, we decided to solely recruit women.

Additionally, in order to maximize the effectiveness of the intervention, eligible participants were screened for generativity, such that they expressed high generative desire but low generative achievement. Participants were asked to answer questions about how generative they wished to be (i.e., generative desire) and how generative they currently felt (i.e., current generative achievement) using the Generativity Scale (Gruenewald et al., 2015). Answers to items on the scale were measured on a 6-point Likert scale (1 to 6; “disagree strongly” to “agree strongly”) and averaged for each subscale (desire and achievement). Participants were deemed eligible if the difference between their desire and achievement subscale scores (i.e., generative desire – generative achievement) was .20 or higher, indicating that they wished to be more generative than they currently felt.

Prospective participants with the following conditions were excluded: chronic physical or mental health problems that may have impacted the study’s physiological or psychological outcomes (e.g., rheumatoid arthritis, cancer, major depression); regular use of certain prescription medications that may have impacted the study’s physiological outcomes (e.g., immune-modifying drugs, opioids, steroids, psychotropic medications to treat major depression or anxiety); cognitive impairment (Brief Alzheimer Screen less than 26; Mendiondo, Ashford, Kryscio, & Schmitt, 2003); BMI greater than 35; current smoker or excessive caffeine user; or recent nightshift work or time zone shifts (>3 h).

Seventy eight older women (mean age  $70.9 \pm 6.3$  years) enrolled in the study and were randomized into either a 6-week generativity (n=40) or control (n=38) condition. Five participants (n=2 in the generativity condition, n=3 in the control condition) did not complete the

study. Two of these participants were removed by the study investigators for not meeting study eligibility criteria; two participants dropped before completing the post-intervention assessment due to scheduling conflicts; and one participant did not receive the full manipulation due to technical issues. Thus, the final sample that was analyzed consisted of 73 participants, described in further detail below under “characteristics of the sample.”

Participants in both groups were told that the study was examining how writing about experiences may be related to health and biological outcomes. All participants provided written consent before participating. All procedures were approved by the UCLA Human Subjects Protection Committee.

***Pre-intervention assessment.***

Participants began the study at the UCLA Clinical and Translational Research Center (CTRC) where a phlebotomist, who was blind to condition, drew blood in order to assess inflammatory outcomes. Participants then completed self-report measures of generativity, social well-being, and mental and physical health. Finally, the study coordinator, who was blind to condition, gave participants instructions for the writing portion of the study and familiarized them with the online survey and writing format.

***Intervention.***

***General procedures.***

Beginning the week after the pre-intervention assessment, all participants received an email, once weekly for six weeks, with a link to log in to an online system (i.e., SurveyMonkey) to receive their instructions and complete their writing. Participants in both conditions were asked to write once weekly and to write about various topics each week based on recommendations for maximizing efficacy of positive psychological interventions (Layous,

Nelson, & Lyubomirsky, 2012; Lyubomirsky & Layous, 2013). All prompts from both conditions are included in the Appendix.

Across both conditions, participants were instructed not to begin their weekly session until they were able to sit quietly, alone, without distraction and complete the writing in one, uninterrupted session each week. Participants were asked to write for however long they desired, as long as they spent at least ten minutes writing for each session. They were reminded each week that the writing portion of the study was important and that they should “really try to get into the writing experience.” All participants were told not to worry about grammar, spelling, or sentence structure in order to allow them to fully immerse themselves in the writing experience. Participants were also told that their writing would be confidential and only identifiable by an anonymous study identifier, not their personal information.

Each week, immediately after the writing portion of their session was complete, participants were asked to respond to questions assessing their opinion of the writing and their feelings post-writing, as detailed below under “weekly post-writing measures.”

*Generativity condition.*

Participants in the generativity condition were asked to respond to prompts asking them to share their experiences and advice with others. Pilot testing of the generativity prompts revealed that some older adults found it hard to connect with a much younger generation (e.g., people in their twenties), both because of age and generational differences. In response to this pilot testing, the target audience to receive the wisdom and advice from the generativity participants was middle-aged adults. Participants in the generativity condition were asked to provide responses to prompts such as, “What are some of the most important lessons you feel you have learned over the course of your life? If a middle-aged person asked you ‘what have you



learned in your \_\_\_\_ years in this world,' what would you tell him or her? You can think and write about any aspect of life you think would be important to share with middle-aged adults looking for advice. You can also focus on one lesson or several lessons.”

Importantly, during the first week of the intervention, participants in the generativity condition were told that their responses for the next 6 weeks would be compiled (anonymously, with all names and identifying information removed) into a book or website dedicated to helping middle-aged adults, who are on the brink of becoming older adults themselves, gain valuable insights and advice from older adults. This feature of the study was meant to create a concrete target of generativity for the participants, so that the exercise was not merely a journaling intervention. Eventually, the research team will compile participants' anonymous responses into a blog or book, and participants will be informed when the product is published.

In order to convince participants that there is a market and need for the life experiences of older adults, we informed participants in the generativity condition about the Cornell Legacy Project (Pillemer, 2011), which is a collection of advice and life experiences obtained from over 1500 older adults. Participants were shown the positive response to this project (e.g., quotes from reviews and high ratings from readers on Amazon.com and Goodreads.com). The positive reviews of the book (e.g., “I can't imagine anyone whose life will not be enriched by this”) suggesting that individuals have benefited from the experiences shared by these older adults were shared with participants in the generativity condition in order to bolster the idea that people would like to read about the life experiences of older adults. This piece was added to the intervention after pilot testing revealed that older adults may be uncertain of the market for and impact of their life stories and advice. Furthermore, this was used to emphasize to the

participants that the readers of their writings would greatly appreciate the experiences, feelings, and advice that they share.

Each week, participants in the generativity condition were reminded that their writings would be shared with middle-aged adults looking for advice and insight about growing older and that the middle-aged adults reading about their experiences and wisdom would really value and benefit from their contributions.

In order to further bolster the sense that participants were impacting others with their life experiences and advice, participants in the generativity condition were given feedback about their writings after the first week of the intervention. As each participant in the generativity condition completed their first week of writing, their writings (after being made anonymous) were shared with others.

Because the data from the audience needed to be collected quickly, this part of the study was done using Amazon Mechanical Turk (MTurk). MTurk has been established as a source of high-quality data that can be obtained inexpensively and quickly from a diverse sample of people who tend to be internally motivated to complete the studies (Buhrmester, Kwang, & Gosling, 2011). These characteristics of MTurk made it ideal for this portion of the study.

Each MTurk worker was asked to read one writing sample and then rate the writing on its impact and helpfulness (e.g., “I found the writing inspiring,” “The writing provided a valuable life lesson”) using a 4-point scale of “strongly disagree” to “strongly agree.” Five to nine workers rated each sample. Overall, the MTurk workers rated the writings very positively. For example, nearly 80% agreed or strongly agreed that the writing samples from the generativity participants was inspiring and nearly 85% found that the writings provided valuable life lessons.

The research team then selectively picked some of these reactions to share with the

participants in the email to the participants during their second week of the intervention. For example, a participant would receive this paragraph before their email instructions for their second week of writing: “Before you complete today’s session (instructions below), we just wanted to let you know that several people have already read your writing from last week, and they said they found it very inspiring and also mentioned that it provided valuable life lessons. We’re sure even more people will benefit from reading about your experiences and advice from this week and the rest of the study. Thank you so much for contributing to this study so that people can learn from your lifetime of experiences!” This was done so that the participants received immediate positive feedback on the impact of their life stories and advice as they began the study.

*Control condition.*

Participants in the control group were asked to write about topics that were intended to be neutral and descriptive in nature. They were instructed not to think of or describe social features or psychological thoughts linked to the topics. For example, one prompt read: “In the space provided below, please describe what you had for lunch today—what it looked like, how it tasted. If you did not have lunch today, write about the most recent lunch you did have. In your writing, please try to focus on the details of what you ate, how it looked, and how it tasted, rather than on who you were with or what you were thinking about during this time. Use this writing session as an opportunity to paint a detailed picture of your lunch, including as much specific information about the food as you can recall.” Participants in the control condition were also never told their writing would be shared with others.

Because the generativity group received positive feedback after their first week of writing, and we did not want the feedback to drive the between-group effects, we provided the

control condition participants with feedback as well. However, the feedback was unrelated to feelings of generativity and read: “Because last week was your first week in the study, we wanted to make sure that we communicated our instructions clearly to you. A member of our staff took a quick look over your responses to last week’s at-home session and they looked totally fine. Thank you so much for following the instructions!”

### ***Post-intervention assessment.***

Similarly to the pre-intervention assessment, participants had blood drawn and completed self-report measures. Participants were debriefed and paid at a later experimental session, not discussed here. Payment for participation was \$200.

### ***Self-report measures***

#### ***Overview of measures.***

Each week immediately post-writing, participants completed measures of how difficult and enjoyable they found the writing, as well as post-writing measures of feelings of generativity and positivity. At the pre- and post-intervention assessments, self-report measures of global feelings of generativity, social well-being, mental health, and physical symptoms and health, as well as inflammatory measures, were taken.

#### ***Weekly post-writing measures.***

##### ***Difficulty and enjoyment.***

In order to assess participants’ sense of enjoyment and difficulty in writing, participants were asked immediately post-writing to think about the writing that they just did, and then answer “How difficult did you find it to generate an answer to the prompt?” and “How enjoyable did you find writing in response to the prompt?” on a Likert scale of 1 (“not at all”) to 7 (“very much so”). Higher scores indicate greater difficulty/enjoyment.

*Post-writing feelings of generativity and positivity.*

To assess participants' feelings of generativity and positivity post-writing, they were asked to indicate how they "feel right now" in response to three words reflective of generativity (i.e., "helpful," "caring," and "useful") and seven items indicating positive feelings (e.g., "happy," "pleasant," "thankful"). Responses were on a scale of 0 ("not at all") to 4 ("extremely") and means were taken across items to create a generativity scale ( $\alpha = .79$ , assessed at the first week) and a positivity scale ( $\alpha = .86$  assessed at the first week). Higher scores indicate greater feelings of generativity/positivity post-writing.

*Global feelings of generativity.*

*Loyola Generativity Scale*

Participants completed a standardized, reliable measure of generativity (Loyola Generativity Scale; McAdams & De St Aubin, 1992), which includes items assessing key components of generativity, such as feeling needed by others and contributing to society. The questionnaire asks participants to respond to 20 statements (e.g., "I try to pass along the knowledge I have gained through my experiences," "I feel as though my contributions will exist after I die") by indicating "how often the statement applies to you" using a 0 ("the statement never applies to you") to 3 ("the statement applies to you very often or nearly always") scale. Responses are summed across the 20 items, creating a range of possible scores of 0-60. Higher scores indicate higher levels of generativity.

*The Generativity Scale*

As an additional measure of generativity, participants also completed The Generativity Scale, which measures both generative desire and current generative achievement and has good internal reliability (Gruenewald et al., 2015). There are seven items assessing generative desire

(e.g., “I want to make a difference in the lives of others,” “I want to do something that will be valuable to others for a long time”) and six items assessing current generative achievement (e.g., “Right now, I feel like I make a difference in my community,” “Right now, I feel like I will be remembered for a long time”). Both subscales are measured on a 1 (“disagree strongly”) to 6 (“agree strongly”) scale, and items are averaged across each subscale to create measures of generative desire and achievement. Higher scores indicate higher levels of generativity.

### ***Social well-being.***

#### *Lifestyle Activities Questionnaire: Social Activities*

In order to measure participation in social activities, participants were asked to complete the Lifestyle Activities Questionnaire (Carlson et al., 2011; Parisi et al., 2015), a measure used to measure lifestyle activities in previous interventions in older adults (i.e., Baltimore Experience Corps Trial; Parisi et al., 2015; Parisi et al., 2012). The social domain of the questionnaire includes eight items assessing: participation in clubs and organizations, attending religious services, visiting with others, going to movies, going to plays/concerts, assisting family members or friends, playing cards or games, and baby-sitting grandchildren or others. Participants are asked to rate the frequency they participate in these activities (0 “never, or less often than once a month” to 5 “everyday”). Responses are then weighted to reflect a 30-day scale (e.g., never = 0 days/month to everyday = 30 days/month; for further details on scoring, see Carlson et al., 2011; Parisi et al., 2015) and averaged across items. Higher scores indicate more frequent participation in social activities.

#### *UCLA Loneliness Scale*

Participants completed the UCLA Loneliness Scale, a valid, reliable scale measuring subjective feelings of social isolation (Russell, 1996). Participants are asked to respond to 20

items assessing feelings of social disconnection and loneliness, such as “how often do you feel alone?” and “how often do feel that your relationships with others are not meaningful?” on a scale of 1 “never” to 4 “always.” Responses to the items are summed, creating a possible range of scores of 20 to 80. Higher scores indicate more loneliness.

#### *Social Provisions Scale*

As a measure of social support, participants completed the Social Provisions Scale, a valid, reliable scale (Cutrona, 1984; Cutrona & Russell, 1987) composed of 24 items assessing the support provided by the participant’s social relationships. Participants indicate their response to the statements using a 1 “strongly disagree” to 4 “strongly agree” scale. The 24 items are summed to create a total score, creating a possible range of scores of 24 to 96. Higher scores indicate more perceived social support.

#### ***Mental health.***

##### *Expectations Regarding Mental Health Scale*

In order to measure participants’ expectations regarding aging in the mental health domain, the Expectations Regarding Mental Health Scale (of the 12-item Expectations Regarding Aging Survey) was used (Sarkisian, Steers, Hays, & Mangione, 2005). The 4-item scale is a valid and reliable measure of participants’ beliefs about mental functioning as a function of age (e.g., “it’s normal to be depressed when you are old,” “being lonely is just something that happens when people get old”). Participants indicate their agreement with the statements (1 “definitely true” to 4 “definitely false”). Scores are summed and transformed to be out of a possible range of 0-100. Higher scores indicate more positive expectations regarding aging in the mental health domain.<sup>1</sup>

##### *Psychological Distress*

Anxiety, depression, and stress are highly interrelated psychological concepts, especially in a healthy sample such as the one in the present study. Additionally, they have been conceptualized together as reflecting psychological distress (Baker & Moore, 2008; Lovibond & Lovibond, 1995). Thus, rather than investigating anxiety, depression, and stress separately, we created a composite for psychological distress by standardizing and summing three widely-used, reliable measures used to assess anxiety (Spielberger Trait Anxiety; Spielberger, 2010), depression (Beck Depression Inventory; Beck, Steer, & Carbin, 1988), and perceived stress (Perceived Stress Scale; Cohen, Kamarck, & Mermelstein, 1983).

Indeed, these three scales were significantly correlated with each other ( $r$ 's = .6 - .7,  $p$ 's < .0001), and the results of a principal components analysis revealed that the composite of these three scales reflects a single factor or component. Using the commonly-used Kaiser criteria (Field, 2009; Kaiser, 1960), only one component emerged; only one component had an eigenvalue over 1 (eigenvalue=2.279), and this single component explained 76% of the variance in the indicator variables. Furthermore, all variables had a loading of .8 or better, indicating strongly loading items (Osborne & Costello, 2009). Higher scores on this composite indicate higher levels of psychological distress.

### ***Physical symptoms and health.***

#### *Lifestyle Activities Questionnaire: Physical Activities*

The Lifestyle Activities Questionnaire, mentioned above, was also used to measure participation in physical activities (Carlson et al., 2011; Parisi et al., 2015). As measured in previous interventions with older adults (Parisi et al., 2015; Parisi et al., 2012), the physical domain of the questionnaire includes shopping, gardening, and hunting/fishing/camping. As



described above, responses are weighted to reflect 30-day frequency and averaged. Higher scores reflect greater participation in physical activities.

#### *Expectations Regarding Physical Health Scale*

Participants' expectations regarding aging in the physical health domain were measured using the Expectations Regarding Physical Health Scale (of the 12-item Expectations Regarding Aging Survey; Sarkisian et al., 2005). The 4-item scale is a valid and reliable measure of participants' beliefs about physical functioning as a function of age (e.g., "when people get older, they need to lower their expectations of how healthy they can be"). Participants indicate their agreement with the statements (1 "definitely true" to 4 "definitely false"). Scores are summed and transformed to be out of a possible range of 0-100. Higher scores indicate more positive expectations regarding aging in the physical health domain.

#### *Cohen-Hoberman Inventory of Physical Symptoms: Pain and Fatigue*

The Cohen-Hoberman Inventory of Physical Symptoms (Cohen & Hoberman, 1983), a reliable scale in which participants are asked to indicate how much common physical symptoms have bothered them from 0 ("not at all") to 4 ("extremely"), was used to assess physical symptoms. In order to reduce response burden, participants were asked to report on only the pain-related (8 items: back pain, headache, migraine headache, stomach pain, pains in heart or chest, muscle tension or soreness, muscle cramps, severe aches and pains;  $\alpha=.59$ ) and fatigue-related (4 items: faintness, constant fatigue, felt weak all over, feeling low in energy;  $\alpha=.66$ ) items on the scale. Scores were summed across the pain and fatigue items, with higher scores indicating more pain/fatigue.

#### *Pittsburgh Sleep Quality Index: Global Score*

In order to measure sleep quality, the Pittsburgh Sleep Quality Index was used, which is a reliable, valid measure assessing sleep quality (Backhaus, Junghanns, Broocks, Riemann, & Hohagen, 2002; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The global score was of interest here, which is created by summing seven components related to sleep quality, including sleep duration, sleep disturbance, sleep latency, day dysfunction due to sleepiness, sleep efficiency, use of medications to aid sleep, and subjective overall sleep quality. The scores on the global sleep quality score range from 0 to 21, where greater scores reflect poorer sleep quality.

### ***Inflammatory measures.***

#### ***Plasma levels of cytokines.***

Venous whole blood was collected using EDTA, held on wet ice until centrifuged at 4°C, and plasma aliquots prepared and frozen at -80°C until performance of immunoassays. Plasma concentrations of IL-6 and TNF- $\alpha$  were determined by high-sensitivity ELISA (R&D Systems, Minneapolis, MN) according to the manufacturer's protocol. The lower limits of the two assays (i.e., concentrations of the lowest standard on the standard curve, also known as the lower limit of quantitation) were 0.2 and 0.5 pg/mL, respectively. Samples with undetectable values were treated as missing data. All samples were assayed in duplicate, and pre- and post-intervention samples from each participant were assayed on the same plate. The inter-assay coefficients of variation (CVs) for IL-6 and TNF- $\alpha$  were 4.9% and 19.6%, respectively; the mean intra-assay CVs for IL-6 and TNF- $\alpha$  were 3.6% and 9.1%, respectively.

#### ***Gene expression and bioinformatics.***

Genome-wide transcriptional profiling was conducted on peripheral blood mononuclear cells (PBMC) isolated by density gradient centrifugation from heparinized whole blood, preserved in RLT lysis buffer (Qiagen), and frozen at -80°C until RNA extraction was

performed. RNA was extracted from preserved frozen PBMC samples (Qiagen RNeasy) and checked for suitable mass (> 100 ng by NanoDrop 1000) and integrity (RNA integrity number > 8 by Agilent TapeStation capillary electrophoresis). All samples meeting quality criteria were assayed by RNA sequencing in the UCLA Neuroscience Genomics Core Laboratory using Illumina TruSeq cDNA library synthesis and multiplex DNA sequencing on an Illumina HiSeq 4000 instrument with single strand 65 bp sequence reads. Each sample yielded >10 million sequence reads, each of which was mapped to the RefSeq human genome sequence using HISAT2 software (D. Kim, Langmead, & Salzberg, 2015) and quantified as transcript counts per million total transcripts using StringTie software (Pertea, Kim, Pertea, Leek, & Salzberg, 2016).

### ***Statistical analyses***

#### ***General analytic strategy.***

All analyses were done using a standard statistical program (SPSS 21.0). When testing between-group effects, analyses of covariance (ANCOVA) were conducted, testing the effect of condition (generativity vs. control) at post-intervention, controlling for baseline (pre-intervention) values. ANCOVA was chosen as the analytic strategy as it increases statistical power in randomized studies; indeed, it has been recommended that “ANCOVA must be used” for studies with random assignment (Van Breukelen, 2006).

Due to known influences of demographic factors (age and white/non-white race) on physical and mental health outcomes, all analyses initially controlled for these factors as covariates but were dropped if not significant ( $p > .1$ ). Additionally, due to known effects of body mass index (BMI), illness symptoms, and alcohol consumption on inflammation, these factors was controlled for (in addition to age and race) in analyses involving inflammatory

outcomes. Finally, due to the skewed nature of the circulating cytokine data, all analyses on circulating cytokines were performed on natural log-transformed values.

***Gene expression and bioinformatics analyses.***

Transcript-per-million values for each transcript were log<sub>2</sub>-transformed for analysis by a standard linear statistical model estimating the magnitude of change in transcript abundance over time (difference score: post-intervention – pre-intervention) as a function of experimental condition (generativity vs. control), with ancillary analyses additionally controlling for individual differences in age, BMI, white vs. non-white race, presence of illness symptoms near the time of blood sampling, and alcohol consumption (history of smoking was also measured but was absent in all subjects), or controlling for mRNA transcripts indicating the relative prevalence of leukocyte subsets within the total PBMC pool (*CD3D*, *CD3E*, *CD4*, *CD8A*, *CD19*, *NCAM1/CD56*, *FCGR3A/CD16*, and *CD14*).

Genes showing > 1.2-fold differential expression across condition served as input into higher-order bioinformatics analyses testing a priori-specified hypotheses regarding transcription control pathways involved in inflammation (NF-κB, measured by the TRANSFAC position-specific weight matrix V\$NFKAPPAB\_01) using TELiS promoter sequence analysis (Cole, Yan, Galic, Arevalo, & Zack, 2005), and assessing the relative contribution of CD16<sup>-</sup> classical monocytes versus CD16<sup>+</sup> non-classical monocytes to the observed transcriptome differences using Transcript Origin Analysis (Cole, Hawkey, Arevalo, & Cacioppo, 2011) with reference data from a previous study of isolated monocyte subsets (GSE26913; Wong et al., 2011). Statistical testing was based on standard errors derived from bootstrap resampling of linear model residual vectors (controlling for potential correlation across genes).

## Results

### *Characteristics of the sample*

As described above, 78 participants enrolled in the study; however, 5 participants (n=2 in generativity condition, n=3 in control condition) did not complete the study due to removal by study investigators, dropping out due to scheduling conflicts, or technical issues resulting in not receiving the full study manipulation. Thus, the final sample analyzed consisted of 73 participants (100% female; mean age  $70.9 \pm 6.5$  years; 80.8% white). Of these 73 participants, 35 were randomized into the control condition and 38 were randomized into the generativity condition. The groups were not significantly different on covariates of interest (i.e., age, race, BMI, cold symptoms, alcohol consumption).

### *Weekly intervention*

There was a high completion rate of the intervention, with 72 out of the 73 participants completing 100% of the weekly writing assignments (the remaining participant completed five out of six assignments). Participants in the generativity condition wrote 364 words on average each week, and participants in the control group wrote 395 words on average each week; the average number of words per week was not different between the groups ( $F(1,71)=.579, p > .4$ ).

### *Effects on weekly post-writing measures*

In order to examine differences in participants' experiences immediately post-writing, we tested differences in how difficult and enjoyable the participants found the writing. The generativity group reported finding the writing significantly more difficult (Figure 1A;  $F(1,71)=14.50, p < .001$ ) and marginally more enjoyable (Figure 1B;  $F(1,71)=3.32, p = .07$ ), averaged across all six weeks.

To further probe participants' feelings immediately post-writing, we examined differences between the two groups in post-writing measures of feelings of generativity and

positivity. The generativity group reported feeling more generative (Figure 1C;  $F(1,70)=19.54, p < .001$ ) and more positively (Figure 1D;  $F(1,70)=8.68, p < .01$ ) post-writing, averaged across all 6 weeks.

### ***Effects on global feelings of generativity***

We tested the effects of the generativity intervention on global feelings of generativity by looking at post-intervention differences between the groups on the Loyola Generativity Scale (LGS), as well as the generative desire and generative achievement subscales of the Generativity Scale (GS). Contrary to our hypotheses, the generativity group (vs. control) did not show increases in generativity on either scale (Figure 2A; LGS:  $F(1,70)=.525, p > .4$ ; Figure 2B; GS Desire:  $F(1,69)=.586, p > .4$ ; Figure 2C; GS Achievement:  $F(1,70)=.698, p > .4$ ).

### ***Effects on social well-being***

In order to test the effect of the intervention on social well-being, we examined post-intervention differences between the groups on participation in social activities, feelings of loneliness, and social support. As hypothesized, the generativity group (vs. control group) reported increased participation in social activities post-intervention (Figure 2D;  $F(1,69)=7.61, p < .01$ ). However, the generativity group did not show improvements in feelings of loneliness (Figure 2E;  $F(1,70) = .273, p > .6$ ) or social support (Figure 2F;  $F(1,70)=2.52, p > .1$ ).

### ***Effects on mental health***

We also examined the impact of the intervention on mental health by testing differences between the groups in psychological distress and their expectations regarding aging in the mental health domain post-intervention. As hypothesized, the generativity intervention had a positive impact on psychological distress, with the generativity group (vs. control group) reporting lower psychological distress (Figure 3A;  $(1,69)=4.22, p < .05$ ). However, the intervention did not have

an impact on expectations regarding aging in the mental health domain (Figure 3B;  $F(1,69)=.573, p > .4$ )

### ***Effects on physical symptoms and health***

To probe the effects of the intervention on physical symptoms and health, we tested whether the intervention led to improvements in participation in physical activity, pain symptoms, fatigue symptoms, global sleep quality, and expectations regarding aging in the physical health domain. As hypothesized, the intervention led to significantly more positive expectations regarding aging in the physical domain (Figure 3C;  $F(1,69)=6.47, p < .05$ ) and marginal improvements in participation in physical activity (Figure 3D;  $F(1,70)=3.30, p = .07$ ) post-intervention. However, the intervention did not impact pain symptoms (Figure 3E;  $F(1,70)=2.33, p > .1$ ), fatigue symptoms (Figure 3F;  $F(1,70)=.047, p > .8$ ), or global sleep quality (Figure 3G;  $F(1,70)=.023, p > .8$ ).

### ***Effects on inflammation***

#### ***Circulating cytokines.***

In order to test whether the generativity intervention led to decreases in cytokines, we examined differences between the groups on circulating plasma levels of IL-6 and TNF- $\alpha$  post-intervention. However, the intervention did not lead to any significant change in plasma concentrations of IL-6 (Figure 4A;  $F(1,64)=.743, p > .3$ ) or TNF- $\alpha$  (Figure 4B;  $F(1,54)=.116, p > .7$ ).

#### ***Gene expression and bioinformatics.***

To identify the impact of the generativity intervention on transcriptional control pathways, we conducted promoter-based bioinformatics analyses to evaluate genes showing a  $\geq 1.2$ -fold difference in the magnitude of change from pre- to post-intervention in response to the

generativity (vs. control) condition. A total of 2300 distinct gene transcripts showed a 1.2-fold up-regulation in the generativity group relative to the control group and 811 showed a 1.2-fold down-regulation. Among the genes down-regulated in response to the generativity condition (vs. control) were transcripts encoding the key pro-inflammatory cytokines, *IL1B* and *IL6*.

Using TELiS promoter-based bioinformatics analyses, we examined differences in the prevalence of transcription factor-binding motifs for the pro-inflammatory transcription factor, NF- $\kappa$ B, among all 2,300 genes showing  $\geq 1.2$ -fold up-regulation vs. all 811 showing  $\geq 1.2$ -fold down-regulation as a function of intervention condition. These analyses indicated that NF- $\kappa$ B binding sites were significantly more prevalent within the promoters of genes that were down-regulated in response to the generativity (vs. control) condition (unadjusted: mean difference =  $-.699 \pm$  standard error  $.204$   $\log_2$  ratio,  $p = .0007$ ; adjusted for demographic, behavioral, and BMI covariates:  $-.452 \pm .223$ ,  $p = .0441$ ; adjusted for leukocyte subset distributions:  $-.441 \pm .192$ ,  $p = .0227$ ).

Finally, we tested whether the differentially expressed genes tended to derive from specific cell types known to mediate inflammatory responses – particularly CD16<sup>-</sup> “classical” monocytes (Powell et al., 2013). Transcript Origin Analyses showed that the genes that were relatively down-regulated as a function of the generativity (vs. control) intervention tended to derive predominately from the immature CD16<sup>-</sup> pro-inflammatory monocyte subset (Figure 5; unadjusted: mean diagnosticity z score =  $.194 \pm .106$ ,  $p = .0332$ ; adjusted for demographic, behavioral, and BMI covariates:  $.147 \pm .073$ ,  $p = .0221$ ), whereas genes relatively up-regulated as a function of the generativity (vs. control) intervention derived predominately from the less inflammatory and more reparative CD16<sup>+</sup> monocyte subset (Figure 5; unadjusted:  $.148 \pm .070$ ,  $p = .0170$ ; adjusted for demographic, behavioral, and BMI and covariates:  $.114 \pm .067$ ,  $p = .0438$ ).



## Discussion

This study assessed the impact of a novel writing intervention aiming to increase feelings of generativity. The generativity intervention led to changes across various health and well-being domains, including social well-being, mental health, physical health, and inflammation. Those in the generativity condition reported greater participation in social activities, decreases in psychological distress, more positive expectations of aging regarding physical health, marginally greater participation in physical activities, and reductions in pro-inflammatory gene expression. Although the intervention did not improve global feelings of generativity (i.e., scores on the Loyola Generativity Scale or the Generativity Scale), participants in the generativity condition did feel more generative and more positivity post-writing, as they completed the intervention, suggesting there was some impact on feelings of generativity. Together, these results suggest that this type of brief social psychological intervention can be an effective tool in improving health and well-being in older adults.

Although this is the first investigation of the health effects of a writing-based generativity intervention, the results of the study nicely complement the existing literature on generativity and its related constructs. Correlational studies have found that generativity, as well as feeling useful to others, is linked to positive health outcomes, such as well-being, lower disability, and longevity in older adults (An & Cooney, 2006; Gruenewald et al., 2007; Gruenewald et al., 2012). Relatedly, engaging in productive activities such as volunteering, which may increase feelings of generativity, has also been associated with lower C-reactive protein, a marker of inflammation (S. Kim & Ferraro, 2013). Positive health effects of giving support to others has also been established (Konrath & Brown, 2013), which may be relevant to generativity, particularly if the support-giving is to younger generations.

A few experimental studies also support the notion that generativity may positively impact health and well-being. The Baltimore Experience Corps Trial, an intergenerational volunteering program which increases feelings of generativity, has led to improvements in health in older adults (Gruenewald et al., 2015; Hong & Morrow-Howell, 2010). Similarly, a volunteering intervention in adolescents led to decreases in circulating levels of IL-6 (Schreier, Schonert-Reichl, & Chen, 2013). A recent trial in a community sample of diverse ages also found that prosocial behavior directed towards others led to decreases in pro-inflammatory gene expression (Nelson-Coffey, Fritz, Lyubomirsky, & Cole, 2017). In sum, these correlational and experimental findings point to the potential for generativity, and its related constructs such as volunteering and prosocial behavior, to positively impact well-being and health in older adults, which support the results of the present study.

Why might a generativity intervention lead to such improvements? There are likely several biopsychosocial mechanisms to explain the benefits, but one potential mechanism is through activation of the mammalian caregiving system, as the caregiving system involves dampening of threat-related responding, which may ultimately lead to health benefits (Eisenberger & Cole, 2012). For example, giving support to others has been found to lead to reduced threat-related neural activation and decreases in sympathetic nervous system activity (Inagaki & Eisenberger, 2012, 2015), which may have downstream effects on inflammation and health (Eisenberger & Cole, 2012; Irwin & Cole, 2011). Given that an important component of generativity involves feeling one has contributed to younger generations, generativity may have co-opted this caregiving system. Thus, generativity may lead to improvements in inflammation and ultimately health through dampening of threat-related physiology as part of this caregiving system. Although this study was not designed to test this hypothesis directly, future studies

should test these mechanisms (e.g., by testing caregiving-related neural correlates and mediators of generativity).

Additional psychological mechanisms may also account for the intervention's benefits. For example, by increasing feelings of usefulness and feeling needed by others, the generativity intervention may have also boosted participants' feelings of self-esteem or competence and self-worth. Interestingly, greater self-esteem is associated with reduced inflammatory (O'Donnell, Brydon, Wright, & Steptoe, 2008) and neuroendocrine reactivity (Seeman et al., 1995) to stress. Furthermore, self-esteem is linked to better mental health (Sowislo & Orth, 2013) and some aspects of physical health (Trzesniewski et al., 2006). Thus, a potential increase in self-esteem from the intervention may also help explain the benefits of the intervention and, as measures of self-esteem were not included in the present study, should be directly tested by future studies.

Although this study suggests that generativity can lead to improvements across several health domains, certain limitations should be considered. It is worth noting that while the generativity intervention did improve outcomes across all health domains measured, it did not improve all outcomes. There are several reasons which could contribute to the lack of improvement on these measures. First, there is the possibility that the generativity intervention truly only has an impact on certain variables, not others. Second, there could be floor or ceiling effects on certain variables. For example, while participants in the generativity intervention expressed more positive expectations regarding physical health, they did not improve in their expectations regarding mental health. This may have been partly driven by the fact that the pre-intervention level (across both groups) of expectations regarding aging in the physical health domain were much lower than the mental health domain (physical health mean = 47.8; mental health mean = 77.9). The more positive pre-intervention expectations towards mental health than

physical health suggest that one potential contributor to the lack of the intervention's effect on the mental health domain could be that participants already had more positive expectations of mental health and aging compared to physical health.

Another potential possibility for the lack of effects on particular variables is that the intervention was not long enough to induce improvements on certain variables. For example, the generativity intervention led to reductions in inflammatory biology at the level of specific gene transcript abundance, inferred transcription factor activity, and inferred cellular origin. However, this dampening of pro-inflammatory activity was not reflected in the circulating levels of IL-6 and TNF- $\alpha$ . One potential reason for this is that interventions which take place over a few weeks may not be long enough to impact circulating markers of inflammation. Indeed, psychological interventions which have reduced inflammatory biology have not shown consistent changes in circulating levels of pro-inflammatory cytokines such as IL-6, but instead, have shown reductions in pro-inflammatory gene expression (Bower & Irwin, 2016). It has been suggested that changes in gene expression data may reflect changes earlier in the inflammatory cascade, which may not be immediately reflected in circulating markers (Bower & Irwin, 2016).

Similarly, the generativity intervention led to significant improvements in participants' expectations regarding physical health and marginally increased their physical activity, but did not improve other physical symptoms such as pain, fatigue, and sleep. It is possible that this short intervention began to have an impact on representations of physical health and increases in physical activity, but a longer intervention may have been able to build on these improvements in expectations and activity to ultimately improve physical symptoms. Alternatively, it is also possible that generativity does not affect physical symptoms.

Finally, the study sample was comprised of exclusively women, who were relatively

healthy and predominantly white. Future studies should build on this intervention by examining the impact of a writing-based generativity intervention in men, clinical samples, and more diverse samples. Additional studies may also want to test the effect of giving more personalized and more frequent feedback to generativity participants as they write. For example, a specific person could read a participant's writing each week and write feedback for them each week in order to further increase feelings of generativity and personal relevance of the intervention.

Despite these limitations, the study also has several important strengths. Importantly, it provides the first evidence that a writing-based intervention to increase generativity can impact health and well-being in older adults. The study also included a neutral control group, whereas many positive psychological studies have used negative or "listing of hassles" control conditions (e.g., counting of blessings vs. burdens; Emmons & McCullough, 2003). Another strength of the study is the examination of multiple domains of well-being and health, including social well-being, and mental and physical health. Furthermore, not only is this the first study to examine the influence of generativity on inflammation, but it also included multiple levels of analysis of inflammatory biology including both circulating and gene expression measures of inflammation.

Overall, this study introduces an innovative intervention with positive effects on social, mental, and physical well-being, as well as inflammatory biology. Additionally, the study involved minimal time commitment and physical exertion on the part of the participants, providing a potential intervention that may improve health for large segments of the older adult population who may not be able to or wish to participate in more intensive interventions. Indeed, given the limited physical mobility, time, and cost needed to complete this intervention, this could be a potentially impactful, low-cost, low-effort intervention to improve health and well-being in an aging population.

## Footnotes

1. Due to technical issues, one of the items in the mental health domain of the Expectations Regarding Aging Survey was from the 38-item version of the scale (Sarkisian, Hays, Berry, & Mangione, 2002) rather than the intended 12-item version. The item in the 12-item scale that reads “as people get older they worry more” (item #7) instead read “quality of life declines as people age.” Removing this item from the scale does not change the results of the analyses.

## Figure Captions

### Figure 1.

Effects of intervention on feelings immediately post-writing (averaged across all 6 weeks of intervention). Participants rated a) how difficult it was to answer the prompt, b) how enjoyable they found the prompt, c) how generative they felt immediately after writing, and d) how positive they felt immediately after writing.

### Figure 2.

Effects of intervention on global feelings of generativity and social well-being. Pre- to post-intervention changes are for visual purposes; all analyses were ANCOVAs, examining differences between conditions on post-intervention values, controlling for pre-intervention values (and white/non-white race and age, if  $p < .1$  as covariates). Mean values at pre- and post-intervention shown for a) Loyola Generativity Scale, b) Generative Desire scale of the Generativity Scale, c) Current Generative Achievement scale of the Generativity Scale, d) Participation in social activities on the Lifestyle Activities Questionnaire, e) UCLA Loneliness Scale, f) Total score on Social Provisions Scale

### Figure 3.

Effects of intervention on mental health and physical symptoms and health. Pre- to post-intervention changes are for visual purposes; all analyses were ANCOVAs, examining differences between conditions on post-intervention values, controlling for pre-intervention values (and white/non-white race and age, if  $p < .1$  as covariates). Mean values at pre- and post-intervention shown for: a) Psychological distress (composite of Beck Depression Inventory,

Spielberger Trait Anxiety, and Perceived Stress Scale), b) Expectations Regarding Mental Health on Expectations Regarding Aging Survey, c) Expectations Regarding Physical Health on Expectations Regarding Aging Survey, d) Participation in physical activities on the Lifestyle Activities Questionnaire, e) pain symptoms on Cohen-Hoberman Inventory of Physical Symptoms, f) fatigue symptoms on Cohen-Hoberman Inventory of Physical Symptoms, and g) global score on Pittsburgh Sleep Quality Index

Figure 4.

Effects of intervention on circulating cytokines. Pre- to post-intervention changes are for visual purposes; all analyses were ANCOVAs, examining differences between conditions on post-intervention values, controlling for pre-intervention values (and BMI, age, white/non-white race, illness symptoms, and alcohol consumption). Mean values at pre- and post- intervention shown for circulating levels of: a) IL-6 and b) TNF- $\alpha$ . Figures depict circulating levels for ease of representation, but all analyses were performed on natural-logged values.

Figure 5.

Transcript origin analyses to determine cellular origins of differentially expressed genes ( $\geq 1.2$ -fold down or up-regulated as a function of the generativity intervention). Genes down-regulated as a function of the generativity (vs. control) condition tended to derive predominately from the immature CD16<sup>-</sup> pro-inflammatory monocyte subset, whereas up-regulated genes as a function of the generativity (vs. control) condition derived predominately from the less inflammatory and more reparative CD16<sup>+</sup> monocyte subset.



Figure 1.

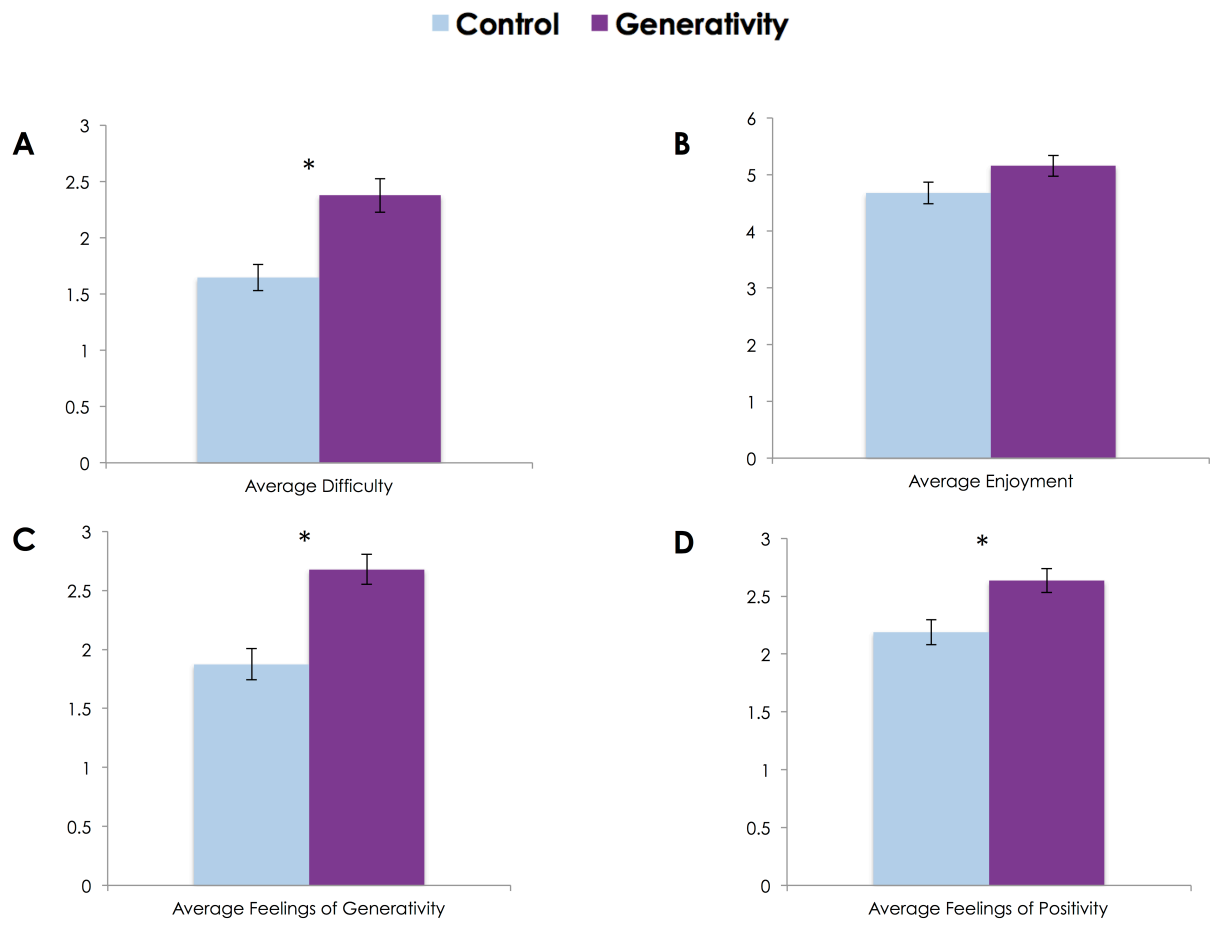


Figure 2.

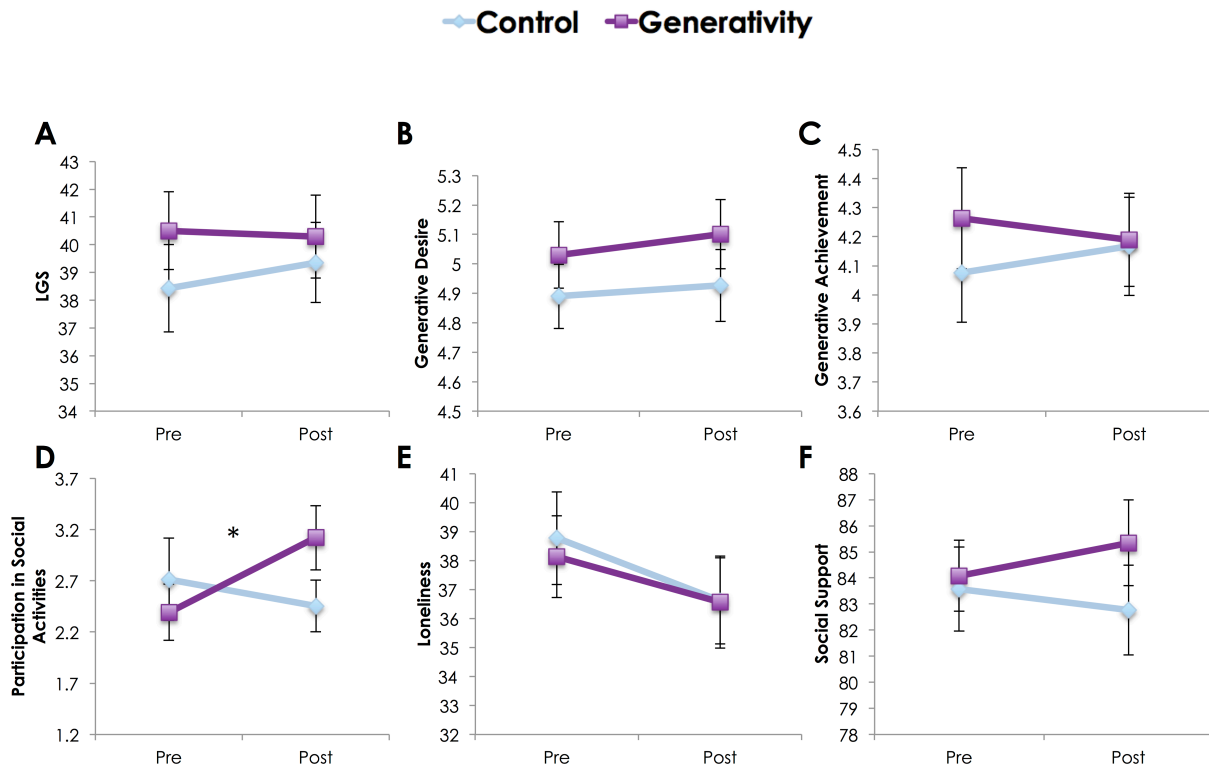


Figure 3.

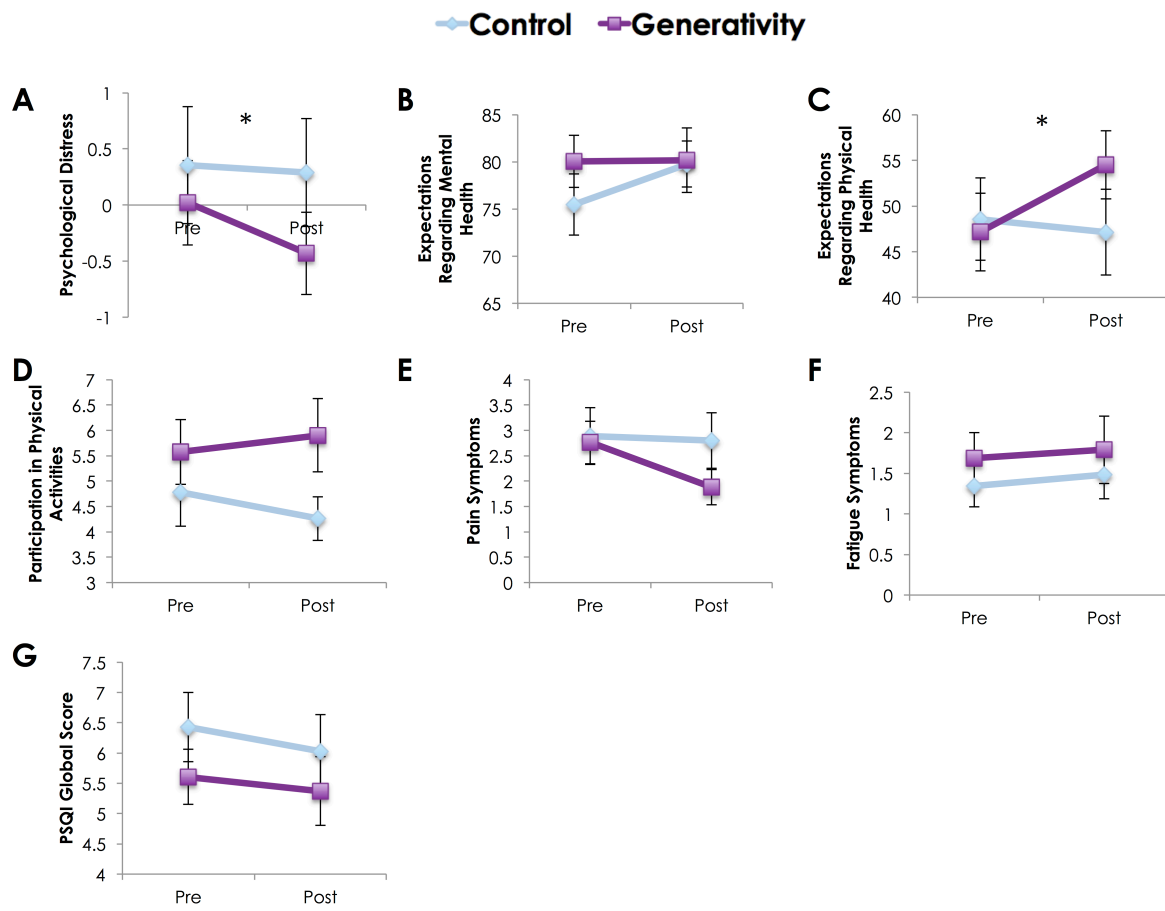


Figure 4.

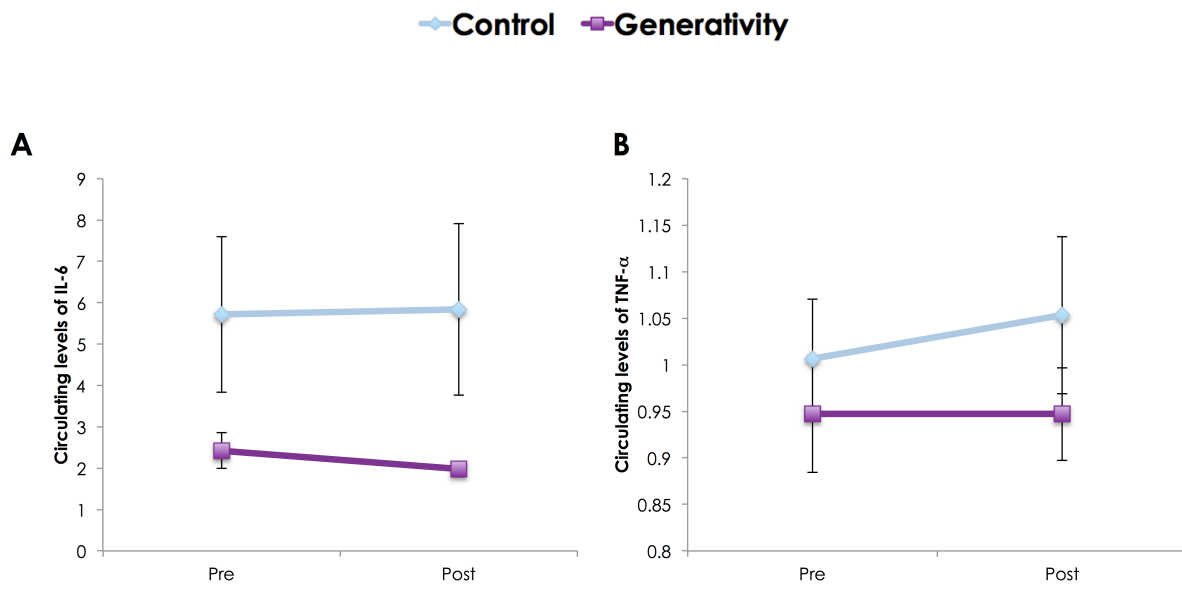
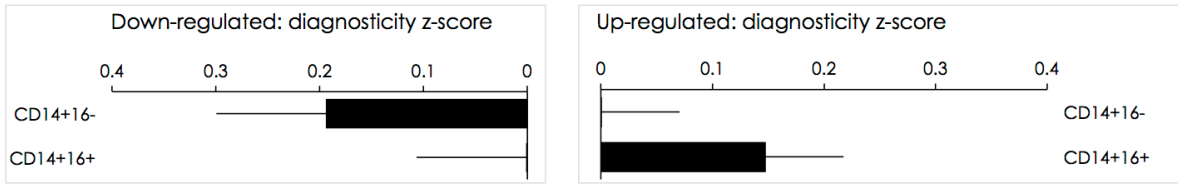


Figure 5.



## Appendix

### *Writing Prompts in Generativity Condition:*

- 1) What are some of the most important lessons you feel you have learned over the course of your life? If a middle-aged person asked you “what have you learned in your \_\_\_\_ years in this world,” what would you tell him or her? You can think and write about any aspect of life you think would be important to share with middle-aged adults looking for advice. You can also focus on one lesson or several lessons.
  
- 2) A large percentage of middle-aged adults worry about how to best live their lives so that they don’t have many regrets when they grow older. What have you learned are the most important things in life? If a middle-aged person looking for advice asked you to think back on your life and think about which parts of your life stick out for you as the most valuable, what would you tell him or her that you think may be helpful?
  
- 3) What would you say you know now about living a happy and successful life that you didn’t know when you were younger? If a middle-aged person who wasn’t sure what components are key for leading a happy and successful life asked for your advice on this, what would you tell him or her? You could choose to focus on one thing or write about multiple things – whatever you think would be best.
  
- 4) Middle-aged adults often have many worries, including about making the right decisions and learning from mistakes and stressful experiences. If you could tell your middle-aged self something, what would you say? Think about what kind of advice you would give yourself when

you were middle-aged. For example, is there anything you wish you had done? Or something you are really happy that you did do? You could also think about what you would say to another middle-aged person if they asked you about this.

5) What advice would you give to people about growing older? If a middle-aged person asked you “what would you say you’ve learned about growing older?” what would you tell him or her? This can be about any part of growing older. For example, you could talk about lessons you’ve learned about staying in good health, maintaining friendships, marriage, raising children, or any other topic you think would be beneficial for middle-aged adults worried about growing older.

6) What have been the most fulfilling activities or experiences in your life? If a middle-aged person concerned about finding meaning in their life asked you “what aspects of your life have been the most meaningful and why?” what would you tell him or her that you think may be helpful? As in previous weeks, feel free to focus on any domain of life (e.g., relationships, career) and talk about one thing or multiple things.

*Writing Prompts in Control Condition:*

1) Now, please take a moment to look around the room you are in at this moment and notice all of the details. In the space provided below, please describe the features of the room in which you are sitting right now. What do you see when you look around? How is the temperature in this room? How does your body feel sitting where you are seated? What kinds of activities can you do in this room? Feel free to describe what the room looks like in general (colors, size), the kinds of objects that are in the room, and other specific details that you notice as you are observing the

visual properties of the room. Please try to focus on the details of what the room looks like as opposed to who is in the room with you or what you are currently thinking about. Use this writing session as an opportunity to paint a detailed picture of what you see in the room you are currently in, including as much specific information as you can.

2) Think about a kind of food or dish that you enjoy making or are able to make. It may be a dish you make for breakfast, lunch, dinner, dessert, or as a snack. In the space provided below, please describe the steps that you take to make this dish. This would include all the different steps that you would go through to create this dish, much like you might see in a cooking magazine or recipe book. Please describing everything from preparing all of the ingredients, going through all of the steps to cook or bake the dish, to getting to the final finished product. Please try to focus on the details of what you do as you prepare this dish (e.g., cutting the vegetables, getting out the bowls, etc.) as opposed to who you are typically with while cooking or eating this dish or what you are typically thinking about as you prepare this dish. Use this writing session as an opportunity to paint a detailed picture of what you enjoy making or are able to make, including as much specific information as you can recall.

3) In the space provided below, please describe your daily routine for getting ready to go to sleep at night. Think about the steps that you go through each night prior to falling asleep (e.g., getting changed, brushing teeth, washing face, reading, or whatever it is that you do) and then write about these different steps that you generally go through as you are getting ready for bed. We would just like you to think back and walk us through this process, describing the details of what you do during this time. Please try to focus on the details of what you do as you get ready to go



to sleep (e.g., pulling back the covers, turning on a fan, turning off a light) as opposed to who you are typically with or what you are typically thinking about during this time. Use this writing session as an opportunity to paint a detailed picture of what do before going to sleep, including as much specific information as you can recall.

4) Think about the longest distance that you walked today. In the space provided below, please describe the longest distance that you walked today and what you saw along the way. Your writing can reference any sort of distance that you walked and it is fine if the longest distance that you walked was not terribly far. We would just like you to think back about what you saw along this walk and try to describe the features of what you noticed along the way. Please try to focus on the details of the types of things that you saw along your walk, rather than on who you were with or what you were thinking about during this time. Use this writing session as an opportunity to paint a detailed picture of what you experienced visually along your walk, including as much specific information as you can recall.

5) In the space provided below, please describe what you had for lunch today—what it looked like, how it tasted. If you did not have lunch today, write about the most recent lunch you did have. In your writing, please try to focus on the details of what you ate, how it looked, and how it tasted, rather than on who you were with or what you were thinking about during this time. Use this writing session as an opportunity to paint a detailed picture of your lunch, including as much specific information about the food as you can recall.

6) Throughout the day, we spend time in rooms with many different physical features and attributes. Think about the room you spent the majority of your time in today. In the space provided below, please describe the features of that room in which you spent most of your time in today. You can describe what the room looks like in general (i.e., colors, size, etc.), the kinds of objects that are in the room, and other specific details that you notice as you are thinking about the visual properties of the room. Please try to focus on the details concerning the physical elements of the room (e.g., the configuration of furniture, the textures of the walls, the contents of the space) as opposed to who you are typically with or what you are typically doing while in this room. Use this writing session as an opportunity to paint a detailed picture of what you saw while in that room, including as much specific information as you can recall.

## References

- An, Jeong Shin, & Cooney, Teresa M. (2006). Psychological well-being in mid to late life: The role of generativity development and parent–child relationships across the lifespan. *International Journal of Behavioral Development, 30*(5), 410-421.
- Backhaus, Jutta, Junghanns, Klaus, Broocks, Andreas, Riemann, Dieter, & Hohagen, Fritz. (2002). Test–retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. *Journal of psychosomatic research, 53*(3), 737-740.
- Baker, James R, & Moore, Susan M. (2008). Distress, coping, and blogging: Comparing new Myspace users by their intention to blog. *CyberPsychology & Behavior, 11*(1), 81-85.
- Beck, Aaron T, Steer, Robert A, & Carbin, Margery G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical psychology review, 8*(1), 77-100.
- Bower, Julianne E, & Irwin, Michael R. (2016). Mind–body therapies and control of inflammatory biology: a descriptive review. *Brain, behavior, and immunity, 51*, 1-11.
- Buhrmester, Michael, Kwang, Tracy, & Gosling, Samuel D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data? *Perspectives on psychological science, 6*(1), 3-5.
- Buysse, Daniel J, Reynolds, Charles F, Monk, Timothy H, Berman, Susan R, & Kupfer, David J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry research, 28*(2), 193-213.
- Carlson, Michelle C, Parisi, Jeanine M, Xia, Jin, Xue, Qian-Li, Rebok, George W, Bandeen-Roche, Karen, & Fried, Linda P. (2011). Lifestyle activities and memory: variety may be

- the spice of life. The women's health and aging study II. *Journal of the International Neuropsychological Society*, 18(2), 286-294.
- Carlson, Michelle C, Seeman, T, & Fried, Linda P. (2000). Importance of generativity for healthy aging in older women. *Aging clinical and experimental research*, 12(2), 132-140.
- Cohen, Sheldon, & Hoberman, Harry M. (1983). Positive events and social supports as buffers of life change stress1. *Journal of applied social psychology*, 13(2), 99-125.
- Cohen, Sheldon, Kamarck, Tom, & Mermelstein, Robin. (1983). A global measure of perceived stress. *Journal of health and social behavior*, 385-396.
- Cole, Steve W, Hawkley, Louise C, Arevalo, Jesusa MG, & Cacioppo, John T. (2011). Transcript origin analysis identifies antigen-presenting cells as primary targets of socially regulated gene expression in leukocytes. *Proceedings of the National Academy of Sciences*, 108(7), 3080-3085.
- Cole, Steve W, Yan, Weihong, Galic, Zoran, Arevalo, Jesusa, & Zack, Jerome A. (2005). Expression-based monitoring of transcription factor activity: the TELiS database. *Bioinformatics*, 21(6), 803-810.
- Cutrona, Carolyn E. (1984). Social support and stress in the transition to parenthood. *Journal of abnormal psychology*, 93(4), 378.
- Cutrona, Carolyn E, & Russell, Daniel W. (1987). The provisions of social relationships and adaptation to stress. *Advances in personal relationships*, 1(1), 37-67.
- Eisenberger, Naomi I, & Cole, Steve W. (2012). Social neuroscience and health: neurophysiological mechanisms linking social ties with physical health. *Nature neuroscience*, 15(5), 669-674.

- Emmons, Robert A, & McCullough, Michael E. (2003). Counting blessings versus burdens: an experimental investigation of gratitude and subjective well-being in daily life. *Journal of personality and social psychology*, 84(2), 377.
- Ershler, William B, & Keller, Evan T. (2000). Age-associated increased interleukin-6 gene expression, late-life diseases, and frailty. *Annual review of medicine*, 51(1), 245-270.
- Ferrucci, Luigi, Harris, Tamara B, Guralnik, Jack M, Tracy, Russell P, Corti, Maria-Chiara, Cohen, Harvey J, . . . Havlik, Richard J. (1999). Serum IL-6 level and the development of disability in older persons. *J Am Geriatr Soc*, 47(6), 639-646.
- Field, Andy. (2009). *Discovering statistics using SPSS*: Sage publications.
- Fisher, Bradley J. (1995). Successful aging, life satisfaction, and generativity in later life. *The International Journal of Aging and Human Development*, 41(3), 239-250.
- Gruenewald, Tara L, Karlamangla, Arun S, Greendale, Gail A, Singer, Burton H, & Seeman, Teresa E. (2007). Feelings of usefulness to others, disability, and mortality in older adults: The MacArthur study of successful aging. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 62(1), P28-P37.
- Gruenewald, Tara L, Karlamangla, Arun S, Greendale, Gail A, Singer, Burton H, & Seeman, Teresa E. (2009). Increased mortality risk in older adults with persistently low or declining feelings of usefulness to others. *Journal of aging and health*, 21(2), 398-425.
- Gruenewald, Tara L, Liao, Diana H, & Seeman, Teresa E. (2012). Contributing to others, contributing to oneself: Perceptions of generativity and health in later life. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 67(6), 660-665.
- Gruenewald, Tara L, Tanner, Elizabeth K, Fried, Linda P, Carlson, Michelle C, Xue, Qian-Li, Parisi, Jeanine M, . . . Seeman, Teresa E. (2015). The Baltimore Experience Corps Trial:

- Enhancing Generativity via Intergenerational Activity Engagement in Later Life. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, gbv005.
- Hong, SI, & Morrow-Howell, Nancy. (2010). Health outcomes of Experience Corps®: A high-commitment volunteer program. *Social science & medicine*, 71(2), 414-420.
- Inagaki, Tristen K, & Eisenberger, Naomi I. (2012). Neural correlates of giving support to a loved one. *Psychosom Med*, 74(1), 3-7.
- Inagaki, Tristen K, & Eisenberger, Naomi I. (2015). Giving support to others reduces sympathetic nervous system-related responses to stress. *Psychophysiology*.
- Irwin, Michael R, & Cole, Steven W. (2011). Reciprocal regulation of the neural and innate immune systems. *Nature Reviews Immunology*, 11(9), 625-632.
- Kaiser, Henry F. (1960). The application of electronic computers to factor analysis. *Educational and psychological measurement*, 20(1), 141-151.
- Keyes, Corey Lee M, & Ryff, Carol D. (1998). Generativity in adult lives: Social structural contours and quality of life consequences.
- Kim, Daehwan, Langmead, Ben, & Salzberg, Steven L. (2015). HISAT: a fast spliced aligner with low memory requirements. *Nature methods*, 12(4), 357-360.
- Kim, Seoyoun, & Ferraro, Kenneth F. (2013). Do Productive Activities Reduce Inflammation in Later Life? Multiple Roles, Frequency of Activities, and C-Reactive Protein. *The Gerontologist*, gnt090.
- Konrath, Sara, & Brown, Stephanie. (2013). The effects of giving on givers. In N. Roberts & M. Newman (Eds.), *Handbook of Health and Social Relationships*: APA Books.

- Layous, Kristin, Nelson, S Katherine, & Lyubomirsky, Sonja. (2012). What is the optimal way to deliver a positive activity intervention? The case of writing about one's best possible selves. *Journal of Happiness Studies*, 1-20.
- Lovibond, Peter F, & Lovibond, Sydney H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour research and therapy*, 33(3), 335-343.
- Lyubomirsky, Sonja, & Layous, Kristin. (2013). How Do Simple Positive Activities Increase Well-Being? *Current Directions in Psychological Science*, 22(1), 57-62.
- McAdams, Dan P, & De St Aubin, Ed. (1992). A theory of generativity and its assessment through self-report, behavioral acts, and narrative themes in autobiography. *Journal of personality and social psychology*, 62(6), 1003.
- Mendiondo, Marta S, Ashford, J Wesson, Kryscio, Richard J, & Schmitt, Frederick A. (2003). Designing a brief alzheimer screen (BAS). *Journal of Alzheimer's Disease*, 5(5), 391-398.
- Nelson-Coffey, S Katherine, Fritz, Megan M, Lyubomirsky, Sonja, & Cole, Steven W. (2017). Kindness in the Blood: A Randomized Controlled Trial of the Gene Regulatory Impact of Prosocial Behavior. *Psychoneuroendocrinology*.
- O'Donnell, Katie, Brydon, Lena, Wright, Caroline E, & Steptoe, Andrew. (2008). Self-esteem levels and cardiovascular and inflammatory responses to acute stress. *Brain, behavior, and immunity*, 22(8), 1241-1247.
- Osborne, Jason W, & Costello, Anna B. (2009). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Pan-Pacific Management Review*, 12(2), 131-146.

- Parisi, Jeanine M, Kuo, Julie, Rebok, George W, Xue, Qian-Li, Fried, Linda P, Gruenewald, Tara L, . . . Tanner, Elizabeth K. (2015). Increases in lifestyle activities as a result of Experience Corps® participation. *Journal of Urban Health*, 92(1), 55-66.
- Parisi, Jeanine M, Rebok, George W, Seeman, Teresa E, Tanner, Elizabeth K, Tan, Erwin J, Fried, Linda P, . . . Carlson, Michelle C. (2012). Lifestyle Activities in Sociodemographically At-Risk Urban, Older Adults Prior to Participation in the Baltimore Experience Corps® Trial. *Activities, adaptation & aging*, 36(3), 242-260.
- Pertea, Mihaela, Kim, Daehwan, Pertea, Geo M, Leek, Jeffrey T, & Salzberg, Steven L. (2016). Transcript-level expression analysis of RNA-seq experiments with HISAT, StringTie and Ballgown. *Nature Protocols*, 11(9), 1650-1667.
- Pillemer, Karl. (2011). *30 Lessons for Living: Tried and True Advice from the Wisest Americans*: Penguin.
- Population Reference Bureau. (2011). World Population Aging: Clocks Illustrate Growth in Population Under Age 5 and Over Age 65. from <http://www.prb.org/Publications/Articles/2011/agingpopulationclocks.aspx>
- Powell, Nicole D, Sloan, Erica K, Bailey, Michael T, Arevalo, Jesusa MG, Miller, Gregory E, Chen, Edith, . . . Cole, Steven W. (2013). Social stress up-regulates inflammatory gene expression in the leukocyte transcriptome via  $\beta$ -adrenergic induction of myelopoiesis. *Proceedings of the National Academy of Sciences*, 110(41), 16574-16579.
- Russell, Daniel W. (1996). UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of personality assessment*, 66(1), 20-40.



- Sarkisian, Catherine A, Hays, Ron D, Berry, Sandra, & Mangione, Carol M. (2002). Development, reliability, and validity of the expectations regarding aging (ERA-38) survey. *The Gerontologist*, 42(4), 534-542.
- Sarkisian, Catherine A, Steers, W Neil, Hays, Ron D, & Mangione, Carol M. (2005). Development of the 12-item expectations regarding aging survey. *The Gerontologist*, 45(2), 240-248.
- Schoklitsch, Angela, & Baumann, Urs. (2012). Generativity and aging: A promising future research topic? *Journal of Aging Studies*, 26(3), 262-272.
- Schreier, Hannah MC, Schonert-Reichl, Kimberly A, & Chen, Edith. (2013). Effect of volunteering on risk factors for cardiovascular disease in adolescents: A randomized controlled trial. *JAMA pediatrics*, 167(4), 327-332.
- Seeman, Teresa E, Berkman, Lisa F, Gulanski, Barbara I, Robbins, Richard J, Greenspan, Susan L, Charpentier, Peter A, & Rowe, John W. (1995). Self-esteem and neuroendocrine response to challenge: MacArthur studies of successful aging. *Journal of psychosomatic research*, 39(1), 69-84.
- Sowislo, Julia Friederike, & Orth, Ulrich. (2013). Does low self-esteem predict depression and anxiety? A meta-analysis of longitudinal studies. *Psychological Bulletin*, 139(1), 213-240.
- Spielberger, Charles D. (2010). *State-Trait Anxiety Inventory*: Wiley Online Library.
- Trzesniewski, Kali H, Donnellan, M Brent, Moffitt, Terrie E, Robins, Richard W, Poulton, Richie, & Caspi, Avshalom. (2006). Low self-esteem during adolescence predicts poor health, criminal behavior, and limited economic prospects during adulthood. *Developmental psychology*, 42(2), 381.

Van Breukelen, Gerard JP. (2006). ANCOVA versus change from baseline had more power in randomized studies and more bias in nonrandomized studies. *Journal of clinical epidemiology*, 59(9), 920-925.

Wong, Kok Loon, Tai, June Jing-Yi, Wong, Wing-Cheong, Han, Hao, Sem, Xiaohui, Yeap, Wei-Hseun, . . . Wong, Siew-Cheng. (2011). Gene expression profiling reveals the defining features of the classical, intermediate, and nonclassical human monocyte subsets. *Blood*, 118(5), e16-e31.

Paper 2:

Generativity and Social Well-Being in Older Women: A Relationship Dependent on  
Expectations Regarding Aging

## **Abstract**

Beliefs about aging can contribute to health and well-being in older adults, including social well-being. Feeling generative, or that one is caring for and contributing to the well-being of others, can also impact health and well-being. In this study, we tested whether expectations regarding aging in the mental health domain would moderate the effect of a generativity intervention (vs. control condition) on social well-being. Participants in this study (n=73, 100% female) were randomly assigned to a 6-week generativity condition, which involved writing about life experiences and sharing advice with others, or control condition, which involved writing about neutral, descriptive topics. Pre- and post-intervention, perceptions of social support and feelings of loneliness were measured. Results revealed that those in the generativity condition with more positive expectations regarding aging in the mental health domain reported greater perceptions of social support and lower levels of loneliness post-intervention. Thus, expectations regarding aging may be an important factor in determining the efficacy of a generativity intervention on social outcomes. These results highlight the importance of studying psychosocial factors in understanding well-being in older adults.

## **Generativity and Social Well-Being in Older Women: A Relationship Dependent on Expectations Regarding Aging**

“I hate that word [anti-aging]! It should be something positive, like pro-aging.”

-Julia Louis-Dreyfus, actress

Many psychological, behavioral, and biological factors can influence health and well-being throughout the aging process. Beliefs about aging are one such important contributor to behavioral and health outcomes in older adults. For example, more positive beliefs about aging are linked with better health and well-being, including increased longevity (Kotter-Gröhn & Hess, 2012; Levy, Slade, & Kasl, 2002; Levy, Slade, Kunkel, & Kasl, 2002; Steverink, Westerhof, Bode, & Dittmann-Kohli, 2001). Beliefs about aging can also impact social outcomes. Expecting to be lonelier as a function of age and stereotyping old age as a time of loneliness is associated with feeling lonelier almost a decade later (Pikhartova, Bowling, & Victor, 2016). Older adults with more positive expectations regarding aging are also more likely to increase social engagement in the future, such as making more new friends (Menkin, Robles, Gruenewald, Tanner, & Seeman, 2016). Together, these findings suggest that having more positive expectations regarding aging may play an important role in shaping older adults' social well-being. In this study, we examined whether beliefs about aging influenced the effects of an intervention aimed at increasing social well-being.

In addition to beliefs about aging, another psychosocial factor that may influence social outcomes in older adults is generativity, or the feeling that one is contributing to others, particularly younger generations. Indeed, generativity, which involves the “need to be needed” (McAdams & De St Aubin, 1992) through a desire to be socially useful to and contribute to others, has been associated with greater psychological and social well-being (Keyes & Ryff,

1998), social support (Hart, McAdams, Hirsch, & Bauer, 2001), and prosocial behavior (Cox, Wilt, Olson, & McAdams, 2010). Furthermore, many older adults experience loneliness due to a loss of meaningful social engagement (Smith, 2012), suggesting low levels of generativity and social usefulness may contribute to subjective feelings of social isolation in this population. Relatedly, it has also been proposed that providing opportunities to participate in generative activity may reduce social isolation in older adults (Carlson, Seeman, & Fried, 2000). Improving such social outcomes in older adults is a public health priority, given that greater loneliness and decreased social support are associated with greater morbidity and mortality (Blazer, 1982; Holt-Lunstad, Smith, & Layton, 2010; Perissinotto, Cenzer, & Covinsky, 2012).

Thus, increasing generativity via an intervention may improve older adults' social well-being, suggesting that generativity interventions may be an effective tool for improving loneliness and social support in older adults. In support of this, previous work has found that a volunteering intervention involving intergenerational contact can increase generativity (Gruenewald et al., 2015) and improve perceptions of social support (Fried et al., 2004) in older adults. However, this type of "high intensity" intervention may not be a proper fit to increase generativity in all older adults, particularly ones with limitations preventing them from participating in intensive volunteering. As such, there is a need to develop generativity interventions which may impact social outcomes but may also be more accessible, such as a writing-based intervention.

Furthermore, given the influence of beliefs about aging on social outcomes, it is possible that positive views about aging may also influence how older adults respond to psychological interventions. Thus, a generativity intervention may only improve social outcomes for older individuals with more positive expectations regarding aging. In support of this notion, positive

psychological interventions are more effective for those who are motivated to and expect to benefit from the activity (Lyubomirsky, Dickerhoof, Boehm, & Sheldon, 2011; Lyubomirsky & Layous, 2013). For older adults who participate in a generativity intervention, having higher expectations regarding aging may serve as one form of expectation that can influence how much they benefit from the intervention.

As such, the goal of this study was to test: 1) whether a novel writing-based generativity intervention increased perceptions of social support and decreased feelings of loneliness and 2) whether expectations regarding aging moderated the effect of the intervention on social outcomes. We hypothesized that the generativity intervention, a social psychological intervention, would lead to greater social improvements for those with more positive expectations regarding aging specifically in the mental health/social domain.

## **Methods**

### ***Participants and procedures***

Detailed information about participants and procedures are described elsewhere (Moieni, 2017) but are summarized here. In brief, participants in the study were healthy women aged 60 and over recruited from the greater Los Angeles area and screened for feeling low in current generative achievement relative to their generative desire (Gruenewald et al., 2015).

All participants were randomized into either a 6-week generativity condition (i.e., writing about topics intended to increase feelings of generativity) or control condition (i.e., writing in response to neutral, descriptive prompts). Immediately pre- and post-intervention, participants completed self-report measures. Participants in both conditions were told that the study was investigating the relationship between writing about experiences and health.

Participants in the generativity condition wrote about their life experiences and shared their wisdom and advice in response to topics such as “What are some of the most important

lessons you feel you have learned over the course of your life? If a middle-aged person asked you ‘what have you learned in your \_\_\_\_ years in this world,’ what would you tell him or her? You can think and write about any aspect of life you think would be important to share with middle-aged adults looking for advice. You can also focus on one lesson or several lessons.” Participants in the generativity condition were informed that their responses to the weekly writings would be collected, made anonymous, and published into a book or website intended to help middle-aged adults transitioning to older adulthood. This was done in order to provide an audience for participants’ generative action. The research team will indeed turn the writings into such a product and inform participants when the product is published. Additional details of the generativity intervention have been described elsewhere (Moieni, 2017).

Participants in the control condition were not told that their writings would be shared with anyone and wrote about neutral, descriptive topics such as: “In the space provided below, please describe what you had for lunch today—what it looked like, how it tasted. If you did not have lunch today, write about the most recent lunch you did have. In your writing, please try to focus on the details of what you ate, how it looked, and how it tasted, rather than on who you were with or what you were thinking about during this time. Use this writing session as an opportunity to paint a detailed picture of your lunch, including as much specific information about the food as you can recall.”

### ***Self-report measures***

#### ***Expectations Regarding Aging Survey.***

The 12-item Expectations Regarding Aging Survey, measured at pre-intervention, is a valid, reliable scale to assess participants’ beliefs about mental health, physical health, and cognitive functioning as a function of age (Sarkisian, Steers, Hays, & Mangione, 2005).



Participants are presented with four statements regarding beliefs about aging and mental health (e.g., “it’s normal to be depressed when you are old”), including two items relevant to the social domain (e.g., “being lonely is just something that happens when people get old”). Similarly, there are four items assessing beliefs about aging and physical health (e.g., “having more aches and pains is an accepted part of aging”) and four items assessing beliefs about aging and cognitive functioning (e.g., “forgetfulness is a natural occurrence just from growing old”). Participants rate how much they believe the statements to be true on a scale of 1 (“definitely true”) to 4 (“definitely false”). Because expectations regarding aging may be domain-specific (Kornadt & Rothermund, 2015) and because both the focus of the intervention was on changing feelings of generativity and social usefulness and the outcomes of interest were social- and mental-health related we expected only the mental health domain of expectations regarding aging to be relevant. Physical health and cognitive functioning were included to show specificity of the mental health domain. Scores are created for expectations regarding aging in each of the three domains (mental health, physical health, and cognitive functioning) by summing across the four items in each scale and translating to a 0-100 scale. Higher scores indicate more positive expectations regarding aging.<sup>1</sup>

### ***Social Provisions Scale.***

The Social Provisions Scale, measured pre- and post-intervention, is a valid, reliable scale to assess perceptions of social support (Cutrona, 1984; Cutrona & Russell, 1987). The scale taps into multiple types of social support, such as feelings of attachment (e.g., “I have close relationships that provide me with a sense of emotional security and well-being”) and social integration (e.g., “there are people who enjoy the same social activities I do). Using a scale of 1 (“strongly disagree”) to 4 (“strongly agree”), participants indicate their agreement with 24

statements. The 24 items are summed to create a total score, creating a possible range of scores from 24 to 96, with greater scores reflecting greater perceived social support.

### ***UCLA Loneliness Scale.***

The UCLA Loneliness Scale, measured pre- and post-intervention, is a valid, reliable scale to assess loneliness (Russell, 1996). Using a scale of 1 (“never”) to 4 (“always”), participants indicate how often they feel certain feelings (e.g., “how often do you feel alone?” “how often do you feel that you lack companionship?”). Scores on the 20 items are summed, creating a possible range of scores from 20 to 80, with higher scores indicating greater feelings of loneliness. Loneliness and perceptions of social support were significantly correlated with each other (assessed at pre-intervention,  $r = -.71, p < .001$ ) but represent distinct constructs with separate, rich literatures and thus were both examined as social outcomes.

### ***General analytic strategy***

A standard statistical program (SPSS 21.0) was used to conduct all analyses. As described previously (Moieni, 2017), to test the main effect of the generativity intervention on perceptions of social support and feelings of loneliness, analysis of covariance (ANCOVA) was used, which is the recommended analytic strategy for randomized studies (Van Breukelen, 2006). Thus, analyses tested the effect of condition (generativity vs. control) on post-intervention values of social support and feelings of loneliness, controlling for pre-intervention values.

In order to test the moderating effect of expectations regarding aging on social support and loneliness, the PROCESS macro for SPSS was used (Hayes, 2012). The PROCESS macro estimates coefficients using OLS regression and automatically calculates interaction terms for moderation analyses. Significant interactions in moderation models can be easily examined using PROCESS, as the macro also generates conditional effects by default. To examine whether

expectations regarding aging moderated the effect of the intervention on social support and loneliness, we tested the interaction of condition (generativity vs. control) and expectations regarding aging on perceptions of social support and loneliness post-intervention, controlling for pre-intervention values.

## **Results**

### ***Characteristics of the sample***

The sample consisted of 73 female participants (mean age  $70.9 \pm 6.5$  years; 80.8% white). Of the 73 participants, 35 were randomized into the control condition and 38 were randomized into the generativity condition.

### ***Main effect of intervention on social support and loneliness***

As described elsewhere (Moieni, 2017), we tested the main effect of the intervention on perceived social support and feelings of loneliness. There was no effect of the generativity intervention on post-intervention perceptions of social support ( $F(1,70)=2.52, p > .1$ ) or feelings of loneliness ( $F(1,70)=.273, p > .6$ ), controlling for pre-intervention values.

### ***Moderating effect of expectations regarding mental health on social support and loneliness***

As hypothesized, there was a significant condition (generativity vs. control) by expectations regarding mental health interaction, such that more positive expectations regarding mental health were associated with greater perceptions of social support post-intervention for those in the generativity condition (vs. control; Figure 1;  $B = .174, SE = .070, 95\% CI = [.034, .313], t = 2.49, p < .05$ ), controlling for baseline values of social support. Analysis of conditional effects revealed that, within the generativity condition, higher expectations regarding aging predicted improvements in perceptions of social support ( $B = .172, SE = .052, 95\% CI = [.068, .276], t = 3.30, p < .01$ ). This effect was not present in the control condition ( $B = -.002, SE = .048, 95\% CI = [-.097, .093], t = -.042, p > .9$ ).

This same pattern of results held true for feelings of loneliness. As hypothesized, there was a significant condition (generativity vs. control) by expectations regarding mental health interaction, such that more positive expectations regarding mental health were associated with lower feelings of loneliness post-intervention for those in the generativity condition (vs. control; Figure 2;  $B = -.164$ ,  $SE = .055$ ,  $95\% \text{ CI} = [-.274, -.055]$ ,  $t = -3.00$ ,  $p < .01$ ), controlling for baseline values of loneliness. Analysis of conditional effects revealed that, within the generativity condition, higher expectations regarding aging predicted improvements in loneliness ( $B = -.115$ ,  $SE = .042$ ,  $95\% \text{ CI} = [-.198, -.031]$ ,  $t = -2.74$ ,  $p < .01$ ). This effect was not present in the control condition ( $B = .050$ ,  $SE = .039$ ,  $95\% \text{ CI} = [-.027, .127]$ ,  $t = 1.29$ ,  $p > .2$ ).

***Moderating effect of expectations regarding physical health and cognitive functioning on social support and loneliness***

To test whether the effects of expectations regarding aging were domain-specific (i.e., specific to expectations regarding mental health), we also tested the moderating effect of expectations regarding physical health and cognitive functioning on perceptions of social support and feelings of loneliness.

As hypothesized, there was no significant condition (generativity vs. control) by expectations regarding physical health interaction for social support ( $B = .064$ ,  $SE = .050$ ,  $95\% \text{ CI} = [-.036, .163]$ ,  $t = 1.28$ ,  $p > .2$ ) or feelings of loneliness ( $B = -.056$ ,  $SE = .039$ ,  $95\% \text{ CI} = [-.134, .023]$ ,  $t = -1.42$ ,  $p > .1$ ). There was also no significant condition (generativity vs. control) by expectations regarding cognitive functioning interaction for social support ( $B = .036$ ,  $SE = .058$ ,  $95\% \text{ CI} = [-.079, .151]$ ,  $t = .620$ ,  $p > .5$ ) or feelings of loneliness ( $B = -.053$ ,  $SE = .044$ ,  $95\% \text{ CI} = [-.140, .035]$ ,  $t = -1.21$ ,  $p > .2$ ).

## Discussion

Here, we tested the effect of a novel writing-based generativity intervention on social well-being and examined whether expectations regarding aging moderated the effect of the intervention on such outcomes. The generativity intervention did not have a main effect on perceived social support or feelings of loneliness. However, there was a significant moderation effect of expectations regarding aging, such that those in the generativity condition with more positive expectations regarding aging in the mental health domain showed greater perceptions of social support and lower feelings of loneliness after the intervention. This effect was domain-specific, such that expectations regarding aging in the physical health and cognitive domains were not significant moderators.

This study provides insight into an important question in intervention development, particularly for novel interventions: for whom is the intervention most beneficial? In regards to the effects of a writing-based generativity intervention on social outcomes, expectations regarding mental health appear to play a role in deriving benefit. While no work has examined this question directly, related prior work supports this finding. For example, participants with greater motivation to become happier, who expect an intervention may lead to benefits, show greater increases in well-being from positive psychology interventions (Lyubomirsky et al., 2011). Although participants in this study were not informed that the generativity intervention was a social well-being intervention and thus could not explicitly expect benefits, their pre-existing expectations regarding aging may have played a similar role.

There are several pathways through which these beliefs about aging may impact social outcomes in a generativity intervention. As suggested by stereotype embodiment theory, one way in which stereotypes of aging can lead to negative outcomes is by creating expectations that act

as self-fulfilling prophecies (Levy, 2009). Thus, participants in the generativity intervention with more negative expectations regarding social and mental well-being as a function of aging may not engage as much in an intervention aiming to increase feelings of social usefulness due to their pre-existing expectations. As a result of this, these participants may not derive as much benefit, leading to less favorable social outcomes as a result of the intervention.

Stereotype embodiment theory also suggests that behavior may be another pathway through which beliefs and stereotypes about aging may impact outcomes (Levy, 2009). For example, priming negative age stereotypes can impair self-efficacy (Levy, Hausdorff, Hencke, & Wei, 2000). In the context of this study, impairments in self-efficacy as a result of more negative beliefs about aging may be another pathway for the moderating effects of expectations regarding aging. Those in the generativity condition with lower expectations regarding mental health may feel that they are less effective at providing wisdom and advice to others, and this lower self-efficacy may also inhibit increases in feelings of social usefulness and generativity, driving the moderating effects.

Our findings support the notion that beliefs about aging may be domain-specific (Kornadt & Rothermund, 2015). In this study, both the focus of the intervention and the outcomes measured were in domains relevant to mental health. Although the generativity intervention may impact outcomes outside the social and mental health domain (as described in Moieni, 2017), beliefs about these other domains may not be relevant, as the intervention is focused on changing social psychological feelings. Thus, we tested for the specificity of mental health expectations as a moderator of the intervention's impact on social outcomes. Indeed, expectations regarding mental health, which includes items directly relevant to social well-being, specifically moderated

the effects of the generativity intervention on social outcomes; expectations regarding physical health and cognitive functioning were not significant moderators.

A few limitations should be considered. First, this study was conducted in an exclusively female and mostly white sample, suggesting that future studies should examine these effects in samples of men or more diverse samples. Future studies should also directly examine the proposed mechanisms for the effects, such as examining whether participants' self-efficacy with regards to the generativity writing task is affected as a function of expectations regarding aging. Additionally, the experimental component of this study was the generativity intervention; stereotypes and beliefs about aging were not directly manipulated here and thus causal influences of expectations regarding aging on social outcomes cannot be definitively stated. As such, future studies could elucidate the findings found in this study by experimentally manipulating both generativity and expectations regarding aging to make causal conclusions.

The study also had several strengths, including the development of a novel generativity intervention for older adults. It also included measures of both social support and loneliness, allowing effects to be examined across multiple social outcomes. Loneliness and social support are both significant contributors to health outcomes (Blazer, 1982; Holt-Lunstad et al., 2010; Perissinotto et al., 2012; Uchino, Cacioppo, & Kiecolt-Glaser, 1996) and critical to study in the context of aging. Finally, examining moderators of interventions is an important area of investigation, allowing us to understand who may benefit the most from future interventions (Kraemer, Wilson, Fairburn, & Agras, 2002; Lyubomirsky & Layous, 2013).

In conclusion, this study provides valuable information about the effect of a novel writing-based intervention on social outcomes in older adults. Those with more positive expectations regarding aging, specifically in the mental health domain, may derive the most

benefit from such an intervention. Thus, interventions aiming to improve social well-being through generativity may also need to alter expectations regarding mental health in order to maximize impact.



## Footnotes

1. Due to technical issues, one of the items in the mental health domain of the Expectations Regarding Aging Survey was from the 38-item version of the scale (Sarkisian, Hays, Berry, & Mangione, 2002) rather than the intended 12-item version. The item in the 12-item scale that reads “as people get older they worry more” (item #7) instead read “quality of life declines as people age.” Removing this item from the scale does not change the results of the analyses.

## Figure Captions

Figure 1.

Relationship between expectations regarding mental health and perceptions of social support. Expectations regarding aging scores, displayed regression lines, and all statistical analyses adjusted for pre-intervention values on perceptions of social support.

Figure 2.

Relationship between expectations regarding mental health and feelings of loneliness. Expectations regarding aging scores, displayed regression lines, and all statistical analyses adjusted for pre-intervention values on feelings of loneliness.

Figure 1.

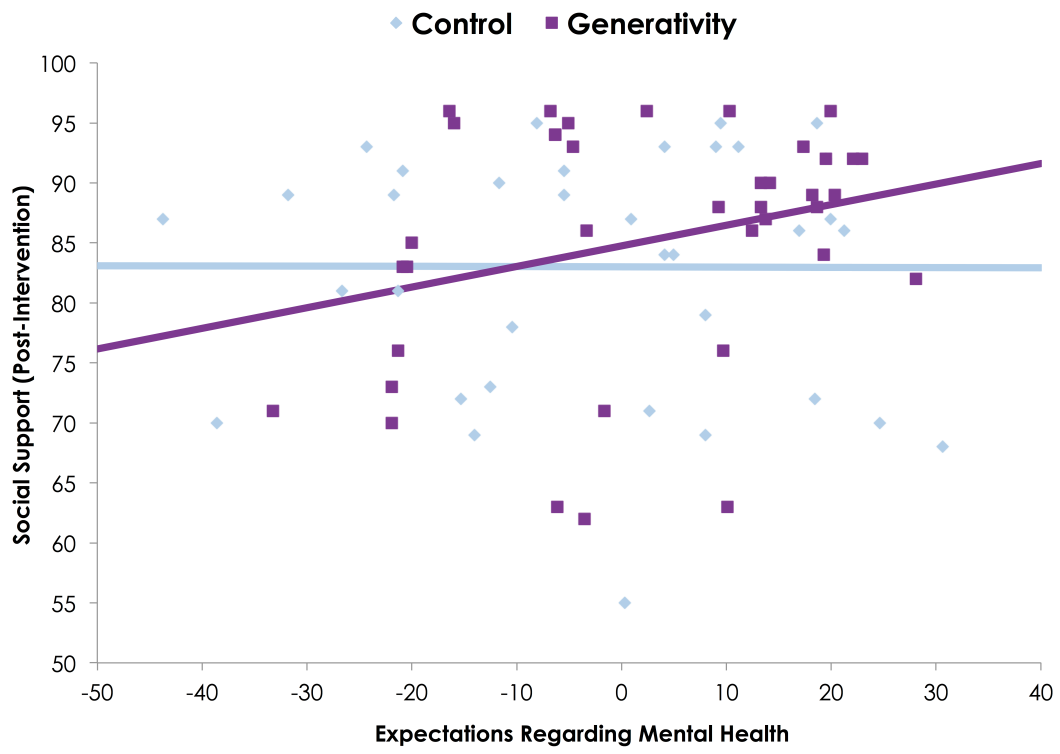
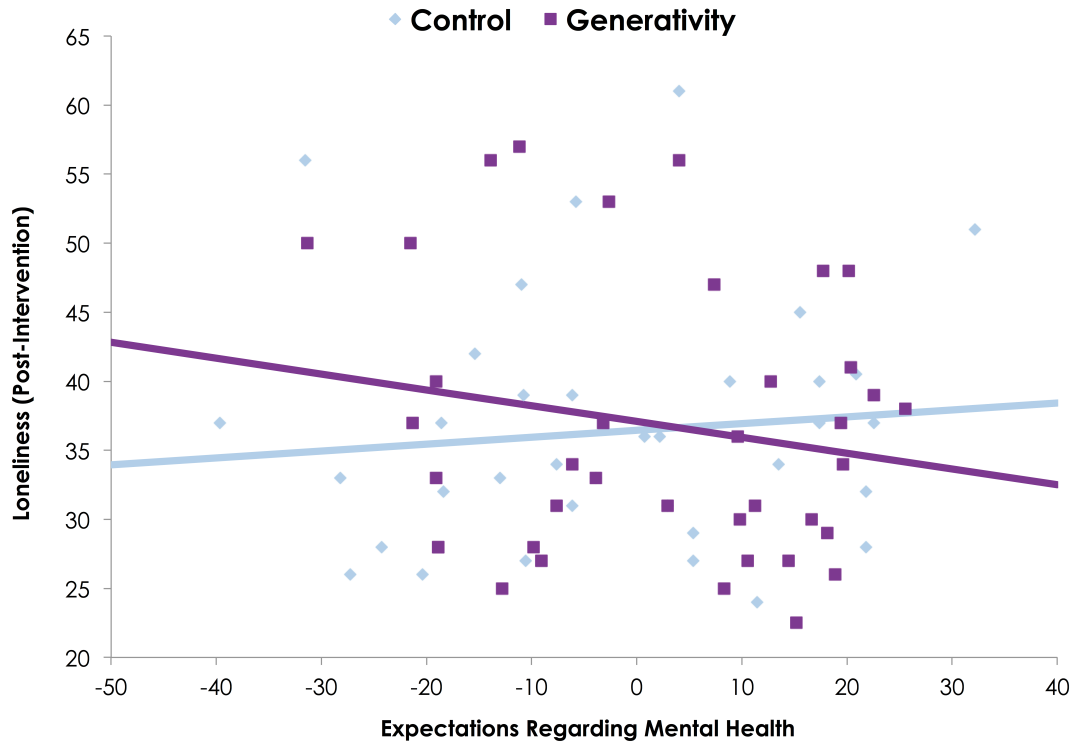


Figure 2.



## References

- Blazer, Dan G. (1982). Social support and mortality in an elderly community population. *American Journal of Epidemiology*, 115(5), 684-694.
- Carlson, Michelle C, Seeman, T, & Fried, Linda P. (2000). Importance of generativity for healthy aging in older women. *Aging clinical and experimental research*, 12(2), 132-140.
- Cox, Keith S, Wilt, Joshua, Olson, Brad, & McAdams, Dan P. (2010). Generativity, the Big Five, and psychosocial adaptation in midlife adults. *Journal of personality*, 78(4), 1185-1208.
- Cutrona, Carolyn E. (1984). Social support and stress in the transition to parenthood. *Journal of abnormal psychology*, 93(4), 378.
- Cutrona, Carolyn E, & Russell, Daniel W. (1987). The provisions of social relationships and adaptation to stress. *Advances in personal relationships*, 1(1), 37-67.
- Fried, Linda P, Carlson, Michelle C, Freedman, Mr Marc, Frick, Kevin D, Glass, Thomas A, Hill, Mr Joel, . . . Tielsch, James. (2004). A social model for health promotion for an aging population: initial evidence on the Experience Corps model. *Journal of Urban Health*, 81(1), 64-78.
- Gruenewald, Tara L, Tanner, Elizabeth K, Fried, Linda P, Carlson, Michelle C, Xue, Qian-Li, Parisi, Jeanine M, . . . Seeman, Teresa E. (2015). The Baltimore Experience Corps Trial: Enhancing Generativity via Intergenerational Activity Engagement in Later Life. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, gbv005.
- Hart, Holly M, McAdams, Dan P, Hirsch, Barton J, & Bauer, Jack J. (2001). Generativity and social involvement among African Americans and White adults. *Journal of Research in Personality*, 35(2), 208-230.

- Hayes, Andrew F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling. *Available:*  
<http://www.personal.psu.edu/jxb14/M554/articles/process2012.pdf>.
- Holt-Lunstad, Julianne, Smith, Timothy B, & Layton, J Bradley. (2010). Social relationships and mortality risk: a meta-analytic review. *PLoS medicine*, 7(7), e1000316.
- Keyes, Corey Lee M, & Ryff, Carol D. (1998). Generativity in adult lives: Social structural contours and quality of life consequences.
- Kornadt, Anna E, & Rothermund, Klaus. (2015). Views on aging: Domain-specific approaches and implications for developmental regulation. *Annual Review of Gerontology and Geriatrics*, 35(1), 121-144.
- Kotter-Grühn, Dana, & Hess, Thomas M. (2012). The impact of age stereotypes on self-perceptions of aging across the adult lifespan. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 67(5), 563-571.
- Kraemer, Helena Chmura, Wilson, G Terence, Fairburn, Christopher G, & Agras, W Stewart. (2002). Mediators and moderators of treatment effects in randomized clinical trials. *Archives of general psychiatry*, 59(10), 877-883.
- Levy, Becca R. (2009). Stereotype embodiment: A psychosocial approach to aging. *Current Directions in Psychological Science*, 18(6), 332-336.
- Levy, Becca R, Hausdorff, Jeffrey M, Hencke, Rebecca, & Wei, Jeanne Y. (2000). Reducing cardiovascular stress with positive self-stereotypes of aging. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 55(4), P205-P213.

- Levy, Becca R, Slade, Martin D, & Kasl, Stanislav V. (2002). Longitudinal benefit of positive self-perceptions of aging on functional health. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 57(5), P409-P417.
- Levy, Becca R, Slade, Martin D, Kunkel, Suzanne R, & Kasl, Stanislav V. (2002). Longevity increased by positive self-perceptions of aging. *Journal of personality and social psychology*, 83(2), 261.
- Lyubomirsky, Sonja, Dickerhoof, Rene, Boehm, Julia K, & Sheldon, Kennon M. (2011). Becoming happier takes both a will and a proper way: an experimental longitudinal intervention to boost well-being. *Emotion*, 11(2), 391.
- Lyubomirsky, Sonja, & Layous, Kristin. (2013). How Do Simple Positive Activities Increase Well-Being? *Current Directions in Psychological Science*, 22(1), 57-62.
- McAdams, Dan P, & De St Aubin, Ed. (1992). A theory of generativity and its assessment through self-report, behavioral acts, and narrative themes in autobiography. *Journal of personality and social psychology*, 62(6), 1003.
- Menkin, Josephine A, Robles, Theodore F, Gruenewald, Tara L, Tanner, Elizabeth K, & Seeman, Teresa E. (2016). Positive Expectations Regarding Aging Linked to More New Friends in Later Life. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, gbv118.
- Moieni, Mona. (2017). *Effects of a Writing-Based Generativity Intervention in Older Women*. (Ph.D. dissertation), University of California, Los Angeles (UCLA), Los Angeles.
- Perissinotto, Carla M, Cenzer, Irena Stijacic, & Covinsky, Kenneth E. (2012). Loneliness in Older Persons A Predictor of Functional Decline and Death Loneliness in Older Persons. *Archives of internal medicine*, 172(14), 1078-1084.

- Pikhartova, Jitka, Bowling, Ann, & Victor, Christina. (2016). Is loneliness in later life a self-fulfilling prophecy? *Aging & mental health, 20*(5), 543-549.
- Russell, Daniel W. (1996). UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of personality assessment, 66*(1), 20-40.
- Sarkisian, Catherine A, Hays, Ron D, Berry, Sandra, & Mangione, Carol M. (2002). Development, reliability, and validity of the expectations regarding aging (ERA-38) survey. *The Gerontologist, 42*(4), 534-542.
- Sarkisian, Catherine A, Steers, W Neil, Hays, Ron D, & Mangione, Carol M. (2005). Development of the 12-item expectations regarding aging survey. *The Gerontologist, 45*(2), 240-248.
- Smith, Judith M. (2012). Toward a Better Understanding of Loneliness In Community-Dwelling Older Adults. *The Journal of Psychology, 146*(3), 293-311.
- Steverink, Nardi, Westerhof, Gerben J, Bode, Christina, & Dittmann-Kohli, Freya. (2001). The personal experience of aging, individual resources, and subjective well-being. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 56*(6), P364-P373.
- Uchino, Bert N, Cacioppo, John T, & Kiecolt-Glaser, Janice K. (1996). The relationship between social support and physiological processes: a review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin, 119*(3), 488.
- Van Breukelen, Gerard JP. (2006). ANCOVA versus change from baseline had more power in randomized studies and more bias in nonrandomized studies. *Journal of clinical epidemiology, 59*(9), 920-925.



## CONCLUSION

“I am certain that after the dust of centuries has passed over our cities, we, too, will be remembered not for our victories or defeats in battle or in politics, but for our contribution to the human spirit.”

-John F. Kennedy

Global population demographics are rapidly changing, with a dramatic shift towards a greater percentage of older adults in the population (Population Reference Bureau, 2011). This unprecedented growth in this segment of the population underlines the necessity of studying processes relevant to health and well-being in older adults. One psychosocial construct which can contribute to successful aging is generativity, or concern and care for promoting the well-being of others, particularly future generations (Fisher, 1995). Although an understudied phenomenon in the aging literature (Schoklitsch & Baumann, 2012), preliminary evidence suggests that older adults with greater perceptions of generativity and feelings of usefulness to others have a lowered risk for morbidity and mortality (Gruenewald et al., 2007, 2009; Gruenewald et al., 2012). As such, increasing feelings of generativity via an intervention may be an effective way to improve health and well-being in older adults. This dissertation project aimed to develop and test such an intervention.

In Paper 1, the effects of a novel writing-based generativity intervention on health and well-being were described. The intervention was designed to be a low-effort, low-intensity activity, so that, if effective, it could ultimately be accessible to large swaths of the older adult population. Once weekly over six weeks, participants who were randomly assigned to the generativity condition wrote about their life experiences and shared their wisdom and advice. In

order to enhance feelings key to generativity, such as feeling useful to and needed by others, participants were told their writings would be shared with middle-aged adults. Those randomly assigned to the control condition also wrote once weekly for six weeks but about neutral topics which would not be shared with others. At the end of the six weeks, those who went through the generativity intervention showed improvements across multiple domains of health and well-being. At post-intervention, those in the generativity (vs. control) condition reported greater participation in social activities, lower psychological distress, and more positive expectations regarding physical health. Gene expression and bioinformatics analyses also revealed that the intervention led to decreases in pro-inflammatory biology. Although no studies had previously examined the relationship between generativity and inflammation, this finding complements previous work showing that psychological constructs and activities relevant to generativity, such as greater eudaimonic well-being, prosocial behavior, and participation in socially productive activities, are related to lower inflammation (Cole et al., 2015; Fredrickson et al., 2013; Kim & Ferraro, 2013; Nelson-Coffey, Fritz, Lyubomirsky, & Cole, 2017).

Paper 1 contributes to the literature on psychosocial factors in aging in several ways. First, this paper introduces a novel writing-based generativity intervention. Second, it provides evidence for the ability of this intervention to influence health outcomes across an array of domains, including both self-report and biological outcomes. Furthermore, to our knowledge, no work had previously examined the impact of generativity on inflammatory biology, making this the first study of this relationship. Finally, this paper emphasizes the importance of studying generativity in understanding the health and well-being of older adults. Although a variety of outcomes were measured in this study, the outcomes were certainly not comprehensive. Future studies can build on this intervention to investigate the impact of the intervention on other

measures of health and well-being, such as cognitive functioning (e.g., executive functioning, memory), mobility (e.g., strength and balance), other biological outcomes (e.g., blood pressure, cholesterol), and other psychological measures (e.g., self-efficacy, self esteem). As this study was conducted in older women who were mostly healthy and white, future interventions could also test the effect of the intervention on different age populations (e.g., middle-aged adults writing advice for young adults), male samples, clinical samples, and more diverse samples. Overall, Paper 1 contributed to scientific understanding of generativity through the development of a novel intervention, which had a positive impact on health and well-being and sets the stage for interesting future research.

In Paper 2, another important psychosocial factor—expectations regarding aging—was investigated in the context of this generativity intervention. Stereotypes and beliefs about aging can have an impact across a wide variety of health outcomes in older adults, including physical health, cognitive functioning, mental health, and social well-being. Given that beliefs about aging may impact social outcomes, Paper 2 examined whether expectations regarding aging in the mental health domain were a moderator of the effect of the generativity intervention on social support and loneliness. Indeed, results revealed that those in the generativity intervention condition with more positive expectations regarding aging in the mental health domain reported greater perceptions of social support and lower feelings of loneliness post-intervention. This effect was specific to expectations in the mental health domain, as expectations regarding physical health and cognitive functioning were not significant moderators. Thus, it appears that beliefs about aging in the mental health/social domain may affect the ability of a social psychological intervention to improve social well-being outcomes.

Paper 2 added further insight to the literature on psychosocial factors and aging. In addition to generativity, beliefs about aging can impact health and well-being in older adults and are relevant to examine in the context of psychosocial interventions. Moreover, identifying moderators of interventions is an important scientific endeavor in order to ultimately maximize effectiveness of the intervention. Although the focus of the present intervention was to manipulate feelings of generativity, increasing feelings of generativity in conjunction with improving expectations regarding mental health may be more effective in improving social outcomes in older adults. This remains a question to be tested by future research. Overall, Paper 2 adds to our understanding of how psychosocial factors may contribute, and interact, to influence well-being.

Together, these two papers highlight the need to study psychosocial factors, including generativity and expectations regarding aging, and how they may impact health and well-being in the context of aging. Developing low-cost, low-effort psychosocial interventions is one avenue of scientific research that may aid in improving the well-being of older adults. Future work could build on the results of these findings, furthering the scientific study of psychosocial interventions in older adults, particularly interventions intended to increase feelings of being useful to, needed by, and giving back to others. Furthermore, creating opportunities for additional generative activity may not only improve the health and well-being of those doing the generative acts but may also provide numerous benefits for the people and society on the receiving end of these actions. Indeed, generativity interventions could eventually have broad implications not only for the well-being of the fastest-growing segment of the global population but also for the well-being of the world they will ultimately leave behind.

## REFERENCES FOR INTRODUCTION AND CONCLUSION

- An, Jeong Shin, & Cooney, Teresa M. (2006). Psychological well-being in mid to late life: The role of generativity development and parent–child relationships across the lifespan. *International Journal of Behavioral Development, 30*(5), 410-421.
- Carlson, Michelle C, Seeman, T, & Fried, Linda P. (2000). Importance of generativity for healthy aging in older women. *Aging clinical and experimental research, 12*(2), 132-140.
- Cole, Steven W, Levine, Morgan E, Arevalo, Jesusa MG, Ma, Jeffrey, Weir, David R, & Crimmins, Eileen M. (2015). Loneliness, eudaimonia, and the human conserved transcriptional response to adversity. *Psychoneuroendocrinology, 62*, 11-17.
- Erikson, Erik Homburger. (1964). Childhood and society.
- Fisher, Bradley J. (1995). Successful aging, life satisfaction, and generativity in later life. *The International Journal of Aging and Human Development, 41*(3), 239-250.
- Fredrickson, Barbara L, Grewen, Karen M, Coffey, Kimberly A, Algoe, Sara B, Firestone, Ann M, Arevalo, Jesusa MG, . . . Cole, Steven W. (2013). A functional genomic perspective on human well-being. *Proceedings of the National Academy of Sciences, 110*(33), 13684-13689.
- Gruenewald, Tara L, Karlamangla, Arun S, Greendale, Gail A, Singer, Burton H, & Seeman, Teresa E. (2007). Feelings of usefulness to others, disability, and mortality in older adults: The MacArthur study of successful aging. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 62*(1), P28-P37.
- Gruenewald, Tara L, Karlamangla, Arun S, Greendale, Gail A, Singer, Burton H, & Seeman, Teresa E. (2009). Increased mortality risk in older adults with persistently low or declining feelings of usefulness to others. *Journal of aging and health, 21*(2), 398-425.

- Gruenewald, Tara L, Liao, Diana H, & Seeman, Teresa E. (2012). Contributing to others, contributing to oneself: Perceptions of generativity and health in later life. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 67(6), 660-665.
- Kim, Seoyoun, & Ferraro, Kenneth F. (2013). Do Productive Activities Reduce Inflammation in Later Life? Multiple Roles, Frequency of Activities, and C-Reactive Protein. *The Gerontologist*, gnt090.
- McAdams, Dan P, & De St Aubin, Ed. (1992). A theory of generativity and its assessment through self-report, behavioral acts, and narrative themes in autobiography. *Journal of personality and social psychology*, 62(6), 1003.
- McAdams, Dan P, & de St Aubin, Ed. (1998). Generativity and adult development. *Washington, DC American Psychological Association*.
- Nelson-Coffey, S Katherine, Fritz, Megan M, Lyubomirsky, Sonja, & Cole, Steven W. (2017). Kindness in the Blood: A Randomized Controlled Trial of the Gene Regulatory Impact of Prosocial Behavior. *Psychoneuroendocrinology*.
- Population Reference Bureau. (2011). World Population Aging: Clocks Illustrate Growth in Population Under Age 5 and Over Age 65. from <http://www.prb.org/Publications/Articles/2011/agingpopulationclocks.aspx>
- Schoklitsch, Angela, & Baumann, Urs. (2012). Generativity and aging: A promising future research topic? *Journal of Aging Studies*, 26(3), 262-272.