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MEANS, GENES, AND MEANINGS: SCIENTIFIC UNDERPINNINGS FOR PERSONAL GROWTH AND LASTING HAPPINESS

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MEANS, GENES, AND MEANINGS: SCIENTIFIC UNDERPINNINGS FOR
PERSONAL GROWTH AND LASTING HAPPINESS

BY

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
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MASTER OF ARTS THESIS

OF

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2019

Abstract

Statement of the problem: Positive psychology has led to a proliferation of research on many positive phenomena, however there lacks theoretical organization among constructs (Gable & Haidt, 2005; Held, 2004; Pawelski, 2016). In an effort to ground research on diverse but related subjects, Christine Winston (2016) suggested that there may be a more basic developmental process underpinning phenomena. Her theory relies heavily on existentialism and humanistic psychology with no data analysis included as empirical validation. The goal of this thesis is to provide a scientific analysis of the credibility of her claims.

Methods: The first manuscript is a metrical analysis to account for a lack of empirical scales in existentialism and humanism. A summary scale is provided to specifically assess development of happiness as described by Winston (2016). Exploratory and confirmatory factor analyses are used with a sample of 310 undergraduate psychology students to accomplish this goal. The second manuscript considers physiological underpinnings to Winston's (2016) theory. Canonical correlation analysis is used on a sample of 20 psychology students (10 undergraduate, 10 graduate) to consider relationships between Winston's (2016) forms of happiness and biomarkers cortisol, interleukin-6, and DNA methylation.

Summary of results: Results were significant and directionally as hypothesized drawing from Winston's (2016) theory. This demonstrates a more basic role of happiness in human functioning. Furthermore, seeing an epigenetic link, this provides preliminary evidence for possible ways to change stable happiness.

Acknowledgements

First and foremost, I need to thank my major professor, Lisa Harlow, for all her support and guidance through this process. I started this program with a desire to learn quantitative methods but little experience therewith. Lisa provided tremendous guidance and educational materials as I explored new methods and theories. She provided great liberty to follow what directions seemed important while sharing her insight and depth of experience. I came to URI because I wanted to learn statistics. Lisa has been an exceptional teacher, however the amount I have learned from her is much broader than math or subjects on this thesis alone. She has shaped my views of research and thinking in general.

I would also like to thank Nasser Zawia for his helping me with the biology in this project. I had been on some research projects and taken some courses in biological sciences during my undergraduate career, which stoked my curiosity without providing much depth of understanding. From consulting to lab space and resources, his involvement was invaluable. It is my belief that the best learning is self motivated. I was truly fortunate that my curiosity was met with personalized instruction and opportunities to pursue my research interests. I have long felt that psychology needs to account for physiology, and Nasser Zawia enabled me to include this in my research.

I would also like to thank my committee at large, specifically Nichea Spillane and the addition now of Bill Bartels as the defense chair. The way I approach problems generally brings together different thoughts from differing backgrounds. I am grateful to have such a diverse committee that accounts for all of the research underpinnings I

conceived of in designing the research project. Nichea Spillane's familiarity with specific subjects in positive psychology was a great addition during the proposal process, and I am looking forward to the philosophical background Bill Bartels will bring to the defense.

Another person I need to thank is Jaunetta Hill, for all her assistance in performing the chemical analysis of the data. I had done some assay work during my undergraduate career but it was all characterized as instructional exercises. I had no idea how much went on behind the scenes to make those instructional exercises possible for undergraduate students to perform. When the time came to perform the chemical assays without the structure of the learning environment, it was clear that I needed help. Jaunetta saved the chemical analysis and the strong results I am sure are directly because of her expertise. But beyond just going through procedures together, she answered my many questions with clarity. Were it not for Jaunetta, this thesis would be very different.

Lastly, I want to thank the Zawia lab in general. The whole lab was very friendly, accommodating, and helpful. Collecting data from undergraduate students can be difficult to schedule, and everybody in the lab was flexible when I needed to bring students in. But beyond the basics of logistics, though I did not know many of them very well, they were always welcoming whenever I was in the lab. I had a lot to learn about bench sciences, and that can make a person feel intimidated or belittled. This is not how I felt working with this lab. Though my background was quite different, I truly felt like a member of the team.

Preface

The thesis is submitted in manuscript format. Two manuscripts are provided: Measuring positivity: Existentialist and humanist metrical additions, and Epigenetic underpinnings of happiness. Neither has been submitted for publication yet. Measuring positivity will be submitted first, to the *Journal of Personality and Social Psychology*. The second manuscript explicitly relies on the metrical development of the first manuscript. For this reason, Epigenetic underpinnings of happiness will be submitted second, to *Developmental Science*.

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Manuscript 1

Measuring positivity: Existentialist and humanist metrical additions

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Abstract

Positive psychology has led to a proliferation of metrics for measuring positive phenomena, however there lacks theoretical organization among constructs (Gable & Haidt, 2005; Held, 2004; Pawelski, 2016). In an effort to ground research on diverse but related subjects, Christine Winston (2016) suggested that there may be a more basic developmental process underpinning phenomena. Drawing from humanism, existentialism, and moral psychology, she argued for the development of personal worldview, however she did not provide empirical validation of her theory. There are two aims to this analysis: to refine scales for measuring constructs in these subfields that do not usually use questionnaires, and to compile from subscales one summary metric measuring development within Winston's (2016) theory. This is done using a sample of 310 undergraduate psychology students. Scale revisions and McDonald's coefficient omega (Dunn, Baguley, & Brunsden, 2014; McDonald, 1999) are reported and general recommendations for researchers are provided.

Keywords: authentic happiness, humanism, existentialism, scale development

Introduction

A key focus of positive psychology research has been to improve measurement of the important things in life (Gable & Haidt, 2005). Scales have been developed to measure various definitions of happiness itself, (Diener, Emmons, Larsen, & Griffin, 1985; Fordyce, 1988; Hills & Argyle, 2002; Lyubomirsky & Lepper, 1999; Peterson, Park, & Seligman, 2005; Watson, Clark, & Tellegen, 1988) as well as happy behaviors including aptitude for gratitude (McCullough, Emmons, & Tsang, 2002), awareness of personal strengths (Govindji & Linley, 2007), experience of hope (Snyder et al., 1991),

and perseverance when times get tough (Duckworth, Peterson, Matthews, & Kelly, 2007). The goal has been to refocus the field of psychology away from what goes wrong toward what goes right (Gable & Haidt, 2005).

With so many individual constructs of happiness, the criticism has been raised that the field lacks theoretical guidance beyond the general pursuit of “positivity” (Gable & Haidt, 2005; Held, 2004; Pawelski, 2016). What stands as one of the largest theories to organize positive phenomena is positive psychology pioneer Martin Seligman’s (2002) authentic happiness theory. This theory considers three different sources of happiness: pleasure, engagement, and meaning. Pleasure is characterized by fun and excitement. An example might be the glitz and glam of a Hollywood party. Engagement is characterized by doing, focusing intently until time stands still. An example might be the jazz musician in a solo, carefully in tune with the energy of the band. Meaning is characterized by connection to something broader than the self. An example might be working for the peace corps: though the work may not be fun or interesting to do, it is inherently worth doing and can provide purpose to one’s life.

While the original theory from Seligman (2002) has been well received, it has been criticized as shallow, overly reducing the full experience of life to happy experiences without accounting for real negativity (Froh, 2004; Gable & Haidt, 2005; Held, 2004; Pawelski, 2016; Seligman, 2011; Waterman, 2013). To account for this, Christine Winston (2016) integrated Seligman’s (2002) theory to ground it in a broader psychological framework. She draws from existentialism and humanism as subfields studying similar subjects to positive psychology but with different theoretical foundations. Importantly, her theory does not downplay the experience of negativity, but

rather incorporates it as an aspect of personal affective development. She argues that there may be a simpler developmental process that underpins development, in essence the development of personal worldview. From there, constructs including happiness, existential despair, and sense of morality can be identified as aspects of this greater developmental transition over the lifespan (Winston, 2016).

The whole system is generally organized similar to Seligman's (2002) theory. Instead of three sources of happiness, three lives are described: the pleasurable life (related to pleasure), the good life (related to engagement), and the meaningful life (related to meaning). Where Seligman (2002) is reluctant to describe these as anything more than personalities or aptitudes for phenomena of happiness, Winston (2016) suggests that they are along a developmental process driven by Abraham Maslow's (Maslow & Frager, 1987) hierarchy of needs. As increasingly abstracted needs are met within Maslow's (1987) humanistic theoretical frame, subjective affective experience can be determined. This includes happiness as defined by Seligman (2002), as well as existential despair as defined Søren Kierkegaard (1989; originally published in 1849). Lastly, the dynamics of delight and ennui ultimately result in a sense of morality and justice as defined by Lawrence Kohlberg (1984). The thought is that there is an interconnected web of psychological constructs that all progress along the same basic path of three stages. Rather than viewing these as unrelated constructs in psychology, an integration of theories across disciplines is offered. Development is simplified to a process of increasing awareness of and acceptance of life's complexity. For a longer discussion of Winston's (2016) theory, see Appendix A.

There are two aims for this analysis: to enable quantitative, empirical research within Winston's (2016) theory; and to provide some preliminary evaluation of the theory. Positive psychology as a field tends to be quantitative (Froh, 2004; Pawelski, 2016; Waterman, 2013), and a scale has been developed for measuring Seligman's (2002) definitions of happiness. That said, research in existentialism, humanism, and moral psychology is not generally scale based, rarely quantitative, and sometimes not even empirical (Lapsley, 1996; van Bruggen, Vos, Westerhof, Bohlmeijer, & Glas, 2015; Waterman, 2013).

Methods

Exploratory factor analysis will be used first to evaluate scale functionality so as to not constrain scales to their expected forms. The goal will be to identify the compatible from the problematic question items to simplify scales. They will be examined as individual subscales and as combined metrics to explore the conditions in which items work together. Factor analyses will be performed before and after removal of question items to identify how changes impacted the scales. Confirmatory factor analysis will then be used to assess explicit hypothesized relationships relating specifically to Winston's (2016) theory. Correlations will be examined between individual items to identify compatible metrics for the PFI and model fit will be assessed. Lastly, McDonald's coefficient omega (Dunn, Baguley, & Brunsden, 2014) will be calculated and reported for all scales. Cronbach's coefficient alpha examines correlations between scale items and may be biased high, especially for scales with many items. Coefficient omega, though less often reported, examines the underlying factor structure of a scale to be more precise in identifying internal consistency.

Materials

The five main scales considered in the first aim of this analysis are the five needs satisfaction measures (FNSM), orientations toward happiness questionnaire (OTH), fear checklist (FC), ethic position questionnaire (EPQ), and self-control scale (SCS).

Selecting question items from these scales, the personal fulfilment inventory (PFI) will be compiled as a summary metric of development across these constructs, the second aim of this analysis. Additionally, the Satisfaction with life scale (SWLS, Diener, Emmons, Larsen, & Griffin, 1985) will be used to assess functionality of the PFI.

The FNSM contains 72 items across five subscales. The subscales directly correspond to Maslow's (1987) hierarchy of needs: physiological needs (15 items), safety security needs (15 items), belongingness needs (15 items), esteem needs (15 items), and self-actualization needs (12 items). For the first four needs, the statement "I am completely satisfied with" is provided followed by a number of statements with which to agree or disagree. Example items include "the amount of water that I drink every day," and "the camaraderie I share with my colleagues." For self-actualization, statements alone are provided; for example, "I completely accept all aspects of myself." Items are rated on a Likert like scale from 1 (representing strongly disagree) to 5 (representing strongly agree).

The OTH contains 18 items across three subscales. The subscales directly correspond to Seligman's (2002) forms of happiness: pleasure (6 items), engagement (6 items), and meaning (6 items). Participants are provided statements with which to agree or disagree. Examples include "I seek out situations that challenge my skills and

abilities,” and “I am always very absorbed in what I do.” Items are rated on a Likert like scale from 1 (representing strongly disagree) to 5 (representing strongly agree).

The FC contains 18 items across three subscales. Though this scale was not specifically developed in relation to Kierkegaard’s (1989) writing, the subscales are taken as corresponding to Kierkegaard’s (1989) forms of despair: despair to not have a self (fear of loss of control, 6 items), despair to not be oneself (fear of loss of social relations, 6 items), and despair to be oneself (fear of loss of identity, 6 items). Participants are provided single word concepts that might spark existential fear. Examples include “weakness,” and “disapproval.” Participants are asked to identify whether or not they fear each item as a binary response, yes or no.

The EPQ contains 20 items across two subscales. This scale was not created for measuring Kohlberg’s (1984) developmental, but the subscales are taken as corresponding to two of Kohlberg’s (1984) developmental stages of morality: preconventional thought (moral relativism, 10 items) and postconventional/principled thought (moral idealism, 10 items). Participants are provided phrases with which to agree or disagree. Examples include “people should make certain that their actions never intentionally harm another even to a small degree,” and “different types of morality cannot be compared as to ‘rightness.’” Items are rated on a Likert like scale from 1 (representing completely disagree) to 9 (representing completely agree).

The SCS contains 10 items, 7 of which are reverse scored. Like the EPQ, this scale was not created for measuring Kohlberg’s (1984) theory, however it was taken as corresponding to Kohlberg’s (1984) conventional morality stage. Participants are provided statements and asked to assess relevance to themselves. Examples include “I

get distracted easily,” and “I’m good at resisting temptation.” Items are rated on a Likert like scale from 1 (representing not at all like me) to 5 (representing very much like me).

The PFI will be created from these scales. The composed final metric will represent a three by four matrix of theoretical interactions. See Figure 1 for a conceptual diagram and Figure 2 for the matrix of theoretical interactions. For additional details on scale compilation, see Appendix B. The final metric will range from 0 (representing low fulfilment) to 4 (representing rich fulfilment). The final items selected for the scale and details on scoring will be provided in Appendix C.

Lastly, the SWLS will be used in evaluating the functionality of the PFI. This scale contains 5 items. This scale is often viewed as a general metric of contentment without explicit operationalizations of happiness. Participants are provided statements with which to agree or disagree. Examples include “I am satisfied with my life,” and “so far I have gotten the important things I want in life.” Items are rated on a Likert scale from 1 (representing strongly disagree) to 7 (representing strongly agree).

Participants

Participants were undergraduate psychology students at the University of Rhode Island compensated with partial course credit. The full sample included 310 participants, however 43 were removed due to active experience of trauma within the past three months or extensively missing data. Participants actively experiencing trauma were removed because the goal of this analysis was to examine basal happiness, trauma being an atypical state of affective experience. Though screening participants based on trauma may induce a selection bias, this allows for more generalizable conclusions. The final sample was of 267 participants. For evaluating metrics in the first aim, 133 cases were

examined; for creating the PFI in the second aim, the 134 remaining cases were examined. The range of ages was from 18 to 55, however the majority of students were young adults ($M=20.08$ years, $SD=3.30$ years). Most students were in their second year of college, however there were students from year one through year five ($M=2.3$ years of college, $SD=0.94$ years of college). The majority of the sample identified as cisgender and female (84%). The majority of the sample primarily identified white (74%) with similarly small proportions of participants identifying as Latinx (8%), African American (7%), mixed race (6%), and Asian/Pacific islander (4%); there was one participant who identified as American Indian.

Results

Background

Table 1 shows descriptive statistics and reliability coefficients for the unedited scales. Generally speaking, most scales were more or less normally distributed although with some kurtosis (i.e., range of skewness from -0.82 to 0.87; range of kurtosis from -0.67 to 3.42). It was slightly concerning that all subscales of the orientation toward happiness scale were kurtotic (pleasure: kurtosis=2.48; engagement: kurtosis=1.05; meaning: kurtosis=1.67; total scale: kurtosis=3.43). Though not ideal, these values are within potentially reasonable research limits per Harlow (2014), and were deemed acceptable for the analysis.

Aim 1: Questionnaire revision

Five Needs Satisfaction Measures (FNSM)

The unedited FNSM demonstrated strong measures of internal consistency, however the combined scale was not very parsimonious. Omega for subscales ranged

from 0.88 to 0.95, however the combined questionnaire provided $\omega=0.97$. This may be in part because the combined questionnaire contains 72 questions. Correlations between individual items were generally positive, significant, with a large range of values from small to large (generally ranging from $r=0.17$ to $r=0.33$; the smallest $r=-0.06$, $p=0.3486$; the largest $r=0.86$, $p<0.0001$). Visual examinations of scatter plots between subscales were generally elliptical and clearly positively correlated. Participants were similarly satisfied on all levels of need satisfaction: physiological needs, $M=3.41$ ($SD=0.63$); safety-security needs, $M=3.75$ ($SD=0.58$); belongingness needs, $M=3.75$ ($SD=0.58$); esteem needs, $M=3.60$ ($SD=0.68$); self-actualization needs, $M=3.20$ ($SD=0.80$); total need satisfaction, $M=3.57$ ($SD=0.52$).

Given the large size of this questionnaire (72 questions total), analysis of subscales independently was given priority over analyzing the scale as one composite. The full results for all factor analyses of the FNSM can be found in Table 2. The physiological need satisfaction subscale was analyzed first, for single factor structure. The first eigenvalue was noticeably larger than the rest (first eigenvalue=7.21), however the following eigenvalues were not unsubstantial (second eigenvalue=2.24). The first three eigenvalues were all above one, however, the first eigenvalue accounted for 48% of the variance, just barely less than the 50% cut off suggested by Harlow (2014). The scree plot demonstrated the second factor slightly before the elbow, but the first eigenvalue was much larger and accounted for nearly 50% of the variance, so this was not considered a threat to unidimensionality. The factor pattern provided strong factor loadings, generally ranging from 0.40 to 0.75, the full range from 0.29 to 0.80. Given the coherent factor

pattern, distinct primary eigenvalue, and large value for coefficient omega, no edits are recommended for the physiological need satisfaction subscale of the FNSM.

A similar result was represented in the safety-security need satisfaction subscale. The first eigenvalue was much larger than the rest, although the first four eigenvalues were above one (first eigenvalue=5.95; second eigenvalue=2.15). The first eigenvalue only accounted for 40% of the variance, which was a bit low. That said, though the elbow of the scree plot was not a sharp turn, it was clear that the second eigenvalue was after the elbow. The factor pattern for the single factor extraction included large loadings, generally around 0.55 to 0.70. The smallest loading was 0.43, while the largest was 0.79. No edits were recommended for the safety-security subscale because of the large primary eigenvalue, factor loadings, and coefficient omega.

Belongingness needs demonstrated slightly clearer one factor structure. As before, the first factor was clearly the largest (eigenvalue=7.21) with multiple eigenvalues above one (second eigenvalue=2.24; third eigenvalue=1.13). However, the scree plot demonstrated a sharper bend in the elbow than for the previous two subscales while the first factor was still the only factor before the elbow. The first factor accounted for nearly half of the variance, 48%. Factor loadings were very large, the range from 0.32 to 0.81 with the majority above 0.70. No edits were suggested for this subscale.

The esteem needs satisfaction subscale had a fairly simple structure. The first eigenvalue was large (eigenvalue=8.89) while the second eigenvalue was the only additional eigenvalue above one (eigenvalue=1.87). This scree plot had a flat and sharp elbow, though the second eigenvalue may have been before the elbow. The range of factor pattern loadings was not as wide as previous subscales (from 0.69 to 0.81), almost

all of the factor loadings were near or above 0.75. This scale may be benefited by simplification to increase parsimony, seeing a large value for omega ($\omega=0.95$). Despite this, no edits were suggested because it clearly functions as a single scale with one primary factor.

Lastly, the self-actualization needs satisfaction subscale showed the most evidence of single factor structure. The first factor eigenvalue was the largest and sole eigenvalue before the elbow of the scree plot. Its value was large (eigenvalue=7.08) while the second eigenvalue was only slightly above one (eigenvalue=1.11). Additionally, the first factor accounted for 59% of the variance. Factor loadings showed an appropriate range of values, all large, most around 0.80, (from 0.56 to 0.86), and omega was quite large for this subscale ($\omega=0.93$). No edits were suggested.

Next, a factor analysis including all 72 total questions was performed to assess the feasibility of the scale as one measure of need satisfaction in general, as well as the underlying factor structure composed of five levels of need fulfilment. Though there were 16 eigenvalues greater than one, this is likely in part because there were so many question items on the scale. Moreover, there was a sharp gradient between the early eigenvalues (first eigenvalue=22.44; second eigenvalue=6.07). It was after four factors had been extracted that more than 50% of the variance had been explained (at this point, 51% of the variance had been accounted for). The scree plot was supportive of the theoretical five factor solution, as there were clearly five factors before the elbow, the sixth at the bend. Looking at the factor pattern when only one factor was extracted, all items had sufficient size loadings. That said, with so many questions, an enormous value

for omega (0.97), and five factors before the elbow of the scree plot, it is not advised to use the FNSM in its entirety as one metric of satisfaction as it is clearly unparsimonious.

To assess the underlying factor structure, five factors were extracted and rotated obliquely. This was supported by the scree plot as well as the theory underpinning the questionnaire characterizing five sources of need satisfaction. Interfactor correlations were small to moderate, ranging from 0.22 to 0.47. Factor loadings were difficult to interpret as items were frequently complex. All items had loadings on at least one factor that were sufficiently large (i.e., $> |0.30|$). Though many items did not demonstrate simple structure, there were trends in how the factor subscales loaded. The physiological needs satisfaction items tended to load onto factors three and four; the safety-security needs satisfaction items tended to load onto factor three and occasionally onto factor four; the belongingness needs satisfaction items tended to load onto factor two and occasionally onto five; the esteem needs satisfaction items tended to load onto factors two and one. The self-actualization needs items showed the simplest structure, tending to load onto factor one. The implications of this factor structure are informative as they provide support for Maslow's (1987) ordering of the hierarchy. For example, items of adjacent stages were more likely to load onto the same factors than items of distant stages.

However, the results also highlight that the factor structure was complex and lacked parsimony. Items were frequently complex and items that were not complex from the same subscale did not always load onto the same factors. These results demonstrate both theoretical validity of the questionnaire, and also the pragmatic limitations of the questionnaire. Though no items were suggested to be removed from the questionnaire,

administering all 72 is not necessary. Seeing individual subscales with clear factor structures, researcher interested in studying need satisfaction could consider individual subscales rather than all 72 items.

Orientations Toward Happiness (OTH)

Despite inflated kurtosis, internal consistency was acceptable for the unedited OTH. The combined scale demonstrated good consistency, $\omega=0.81$. The subscale for happiness as meaning was more internally consistent than the subscales for pleasure or engagement, though all values were within reasonable research limits (meaning: $\omega=0.78$; pleasure: $\omega=0.73$; engagement: $\omega=0.70$). Individual item correlations were small to moderate and significant, generally ranging from $r=0.15$ to $r=0.30$. There were two slightly negative item correlations, however these items were insignificant and on different subscales ($r=-0.11, p=0.0739$; $r=-0.02, p=0.7625$). The vast majority of individual item correlations were positive, the largest correlation $r=0.58, p<0.0001$. Visual examination of scatter plots between subscales were generally elliptical and clearly demonstrating positive relationships. Participants were well oriented toward all forms of happiness: pleasure, $M=3.64$ ($SD=0.58$); engagement, $M=3.27$ ($SD=0.55$); meaning, $M=3.69$ ($SD=0.61$); total happiness, $M=3.53$ ($SD=0.45$).

The full results for the OTH analysis can be found in Table 3. The questionnaire was analyzed first as one summed metric of happiness, then as individual subscales. A three factor structure was apparent, despite some mixed results. The first six eigenvalues were all at or above one (first eigenvalue=4.39; second eigenvalue=2.27; third eigenvalue=1.69; fourth eigenvalue=1.21; fifth eigenvalue=1.15; sixth eigenvalue=1.00), however the scree plot indicated clearly three factors before the bend. These three factors

accounted for 46% of the variance. Given theoretical design around three sources of happiness, the scree plot implying three factors before the elbow, and nearly 50% of the variance explained by the first three factors, three factors were extracted.

Subscales were generally distinguished by their loadings, however there were some items that were complex. Items on the pleasure subscale tended to load onto the second factor; items on the engagement subscale tended to load onto the third factor; and items on the meaning subscale tended to load onto the first factor. Primary factor loadings were large, generally around 0.55 to 0.75 (full range from 0.30 to 0.79). There were some items with low and indiscriminate loadings, for example one item which yielded factor one loading=0.21; factor two loading=0.24; and factor three loading=0.30. Investigating these items within subscales will be important to clarify the scale.

The pleasure subscale was analyzed first. The first eigenvalue was noticeably larger than the rest (first eigenvalue=2.53; second eigenvalue=0.97), and the scree plot demonstrated one factor before the bend. Though this is evidence of a one factor structure, the first factor alone only accounted for 42% of the variance. One factor was extracted. The range of factor loadings was from 0.45 to 0.75, however the majority of loadings were above 0.60. The lowest loading item was a complex loading on the previous three factor analysis of all 18 items (“I go out of my way to feel euphoric”). Seeing as it was the least contributive to the subscale and muddled the combined scale, the analysis was rerun with the item removed. This had minimal impact on the eigenvalues (first eigenvalue=2.40; second eigenvalue=0.86), the scree plot, or coefficient omega (both instances, after rounding omega=0.73) but it did improve the proportion of variance accounted for to 48%. It may be worth considering removal of

this item for future research, especially if the full scale is being used to contrast these sources of happiness.

The engagement subscale was less distinctively single factor than the pleasure subscale. The first two eigenvalues were both above one (first eigenvalue=2.42; second eigenvalue=1.01) and the first eigenvalue was only accounted for 40% of the variance, the first two accounting for 57% of the variance. The scree plot was difficult to interpret, unclear whether or not the second eigenvalue was before the elbow or slightly after. Because of the theory and intended applications of the subscale, only one factor was extracted. Most factor loadings were large, above 0.65; however, one was relatively smaller, (“regardless of what I am doing, time passes very quickly,” loading=0.38). Additionally, this smaller item was a complex loading in the first factor analysis of all 18 items. The analysis was rerun with the item removed. This change improved clarity of single factor structure. The first eigenvalue was the only value above one (first eigenvalue=2.33; second eigenvalue=0.83) and it accounted for 47% of the variance. The scree plot now showed clearly one factor before the elbow. All factor loadings were large, from 0.64 to 0.71. Lastly, removing this items improved internal consistency for the subscale from $\omega=0.70$ to $\omega=0.72$. Researchers interested in the OTH should consider removing this item.

The meaning subscale demonstrated a one-factor structure. The first eigenvalue was well above the rest (first eigenvalue=2.82), though the second eigenvalue was very close to one (eigenvalue=0.99). That said, the first factor accounted for only 47% of the variance, while the adding the second factor increased the total variance accounted for to 64%. The scree plot showed one factor before the bend. This all suggests that there is

one dominant factor. One factor was extracted. Loadings were generally large, around 0.65 to 0.85. There was one item (“I have spent a lot of time thinking about what life means and how I fit into its big picture,”) which loaded relatively less than the other items (loading=0.48). This item was also a complex loading on the initial 18 item three factor analysis. Additionally, there was one item that had a slightly complex loading in the three-factor analysis of all 18 items, that had a slightly lower factor loading relative to the other items in this analysis (“In choosing what to do, I always take into account whether it will benefit other people,” loading=0.60). Both of these items were removed and the analysis rerun. This change distinguished the single factor structure further. The first eigenvalue remained large (eigenvalue=2.40) while the second eigenvalue lowered (eigenvalue=0.74), the scree plot remained similar to its original shape. Proportions of variance accounted for increased, the first factor now accounting for 60% of the variance. Factor loadings were all large, from 0.71 to 0.88. Omega did increase for the subscale, though only marginally from 0.78 to 0.79. Researchers interested in the OTH should consider removing these items, especially if interested in comparing the three sources of happiness.

Having removed these items, the whole scale combining subscales could be considered. Where before, with all 18 items, there was some evidence that there may have been more than three factors, the scale now clearly demonstrated a three-factor structure. The first three eigenvalues were well above one, the fourth eigenvalue was slightly above one but only barely so (first eigenvalue=3.67; second eigenvalue=2.12; third eigenvalue=1.62; fourth eigenvalue=1.10); the scree plot showed clearly that three factors came before the bend; and the first three factors accounted for 53% of the

variance. Removing the problematic items did reduce coefficient omega slightly from 0.81 to 0.79, but these values are still within acceptable limits. Extracting three factors with a promax rotation provided clearer results. Primary factor loadings for each subscale generally large (generally from 0.65 to 0.75, full range from 0.55 to 0.81). Loadings on other factors were larger than would have been ideal, but still much smaller relative to primary factors (generally loadings around 0.10 to 0.20, full range from -0.29 to 0.32). Interfactor correlations were small to moderate (pleasure and engagement: $r=0.13$; pleasure and meaning: $r=0.24$; engagement and meaning: $r=0.22$). Removal of four items ("I go out of my way to feel euphoric" on the pleasure subscale; "Regardless of what I am doing, time passes very quickly" on the engagement subscale; and, "In choosing what to do, I always take into account whether it will benefit other people" and "I have spent a lot of time thinking about what life means and how I fit into its big picture" on the meaning subscale) may be worth consideration to simplify the factor structure.

Fear Checklist (FC)

The unedited FC had reasonable internal consistency for all but one subscale. The overall metric was reasonably consistent (omega=0.82) and so too were the subscales for fear of loss of social relations and control loss of social relations: omega=0.81; loss of control: omega=0.78. However, consistency for fear of loss of identity was very low (omega=0.59). Editing the FC will be essential. Individual item correlations were small to moderate in size and significant, generally ranging from about $r=0.10$ to $r=0.25$. That said, item correlations were occasionally quite small (e.g., $r=0.01$, $p=0.8880$) or even negative (e.g., $r=-0.16$, $p=0.0110$). The highest correlation was $r=0.54$, $p<0.0001$. A

visual examination of scatter plots between subscales demonstrated what appeared to be positive relationships, but clearly there was much variation. Participants were generally moderately fearful overall ($M=8.11$ fears, $SD=3.93$ fears). Participants were not particularly fearful of loss of control ($M=1.57$ fears, $SD=1.83$ fears), but moderately fearful of loss of social relations or loss of identity (social relations: $M=3.53$ fears, $SD=1.75$ fears; loss of identity: $M=3.00$ fears, $SD=1.58$ fears).

The full results of the FC analysis can be found in Table 4. The first factor analysis considered all 18 items with a promax rotation to identify all questions in relation; next, individual subscales were considered in detail. The first five eigenvalues were all above one (first eigenvalue=4.57; second eigenvalue=2.70; third eigenvalue=1.54; fourth eigenvalue=1.15; fifth eigenvalue=1.01). That said, extracting three factors, as was intended for the scale, resulted in 49% of the variance being explained. Moreover, though the scree plot did not have a very sharp bend in the elbow, it was only the first three eigenvalues that were before what bend there was. Because of the scree plot, values close to one for the fourth and fifth eigenvalues, and the theoretical design based on three sources of existential fear, three factors were extracted.

The factor pattern with three factors extracted was mixed. The fear of loss of control and fear of loss of social relations subscales were fairly distinct. Each had a clear primary factor onto which items loaded (control: factor one; social relations: factor two). There were some items that were complex or did not seem to load onto the same factor as other items; however, most items had fairly simple structure with loadings onto the primary factor around 0.65 to 0.75 and loadings onto other factors around 0.05 to 0.15. The fear of loss of identity subscale was less distinct. Three items were complex

and uninformative, with small loadings onto all factors. Two items loaded primarily onto factor one and one item loaded primarily onto factor three. Individual subscale analyses provided clarity on cleaning this scale.

The fear of loss of control subscale was first analyzed, for single factor structure. Only the first eigenvalue was larger than one (first eigenvalue=2.52; second eigenvalue=0.96) and the scree plot identified only one factor before the bend. Though this was strong evidence in support of a single factor structure, the first eigenvalue only accounted for 42% of the variance, the first two accounting for 58%. Factor loadings for one factor extracted were strong, most were around 0.60 to 0.75. There was one item (“control”) for which the loading was only 0.30. This item also did not appear to load onto the same primary item during the first factor analysis of all 18 items as did the other items from this subscale. The item was removed and the analysis was rerun. This clarified the structure. The first eigenvalue decreased slightly, but the second eigenvalue decreased more (first eigenvalue=2.46, second eigenvalue=0.84). Additionally, the first factor accounted for 48% of the variance, close to the 50% desired. The scree plot showed a clear bend before the second eigenvalue. Item loadings were strong, all above 0.60, full range from 0.61 to 0.78. Lastly, removing control from the questionnaire improved omega from 0.72 to 0.74. All in all, removing “control” from this subscale is advised.

Factor analysis of the fear of loss of social relations subscale was performed and one factor extracted to assess the factor structure. The first eigenvalue was clearly the largest and the only eigenvalue above one (first eigenvalue=3.07; second eigenvalue=0.86). The first factor alone accounted for 51% of the variance, and the scree

plot showed the second factor after the elbow. This strong evidence for a single factor structure. Factor loadings were strong, around 0.75. The one exception was the item (“honesty”) which was lower (loading=0.45). Further yet, this item did not primarily load onto the same factor as the other items of this subscale. The factor analysis was performed again with the item removed. The results were strong: the first eigenvalue was still large (eigenvalue=2.92), but the second eigenvalue was smaller (eigenvalue=0.71) and the first eigenvalue accounted for 58% of the variance. The scree plot showed clearly one factor before the elbow and factor loadings were all large, almost all above 0.70, ranging from 0.69 to 0.81. Lastly, omega increased from 0.81 to 0.82. It is recommended that researchers interested in the FC should consider removing “honesty” from the social relations subscale.

The final subscale to be analyzed, fear of loss of identity, was now considered. This scale also showed evidence of a two factor structure. The first two eigenvalues were both above one (first eigenvalue=1.99; second eigenvalue=1.31) but more concerning was that the first factor only accounted for 33% of the variance. It was difficult to assess the scree plot because the eigenvalues were virtually linear. Extracting only one factor identified three items with strong loadings (“failure:” loading=0.66; “disapproval:” loading=0.83; and, “insignificance:” loading=0.75); two items with smaller loadings (“other people’s opinions:” loading=0.44; “anonymity:” loading=0.34); and one item which did not load at all onto the factor (“success:” loading=-0.01). Seeing such little relation for this item, the analysis was repeated with “success” removed. This change did simplify toward a one factor structure, yielding a scree plot with only one large eigenvalue above one before the bend (first eigenvalue=2.46; second eigenvalue=0.84).

The variance this accounted also improved, to 49% of the variance. After rounding, none of the factor loadings had changed. This change did increase coefficient omega from 0.59 to 0.63, though this is still lower than would be desired. Researchers interested in the FC should consider removing “success” from the loss of identity subscale, although the overall integrity of the subscale may still be low for undergraduate populations.

The FC could be again considered now with items removed. Before there had been concern that there may be more than three factors present. Removing fear of loss of honesty, control, and success may have oversimplified the scale somewhat. The first four eigenvalues were above one, however the third and fourth were very close to one (first eigenvalue=4.40; second eigenvalue=2.41; third eigenvalue=1.15; fourth eigenvalue=1.03). The first two accounted for 45% of the variance, the first three 53% of the variance. Most concerning was the scree plot, which showed clearly two factors before the bend, however the third factor was only at the elbow. Extracting three factors with a promax rotation, there was still some complexity between subscales. The fear of loss of control subscale still tended to load onto the first factor (range of loadings from 0.45 to 0.78). There was one item (“rejection”) which before showed simple structure that now was complex (first factor loading=0.45; third factor loading=0.45). The fear of loss of social relations subscale was more straightforward: most items loaded strongly onto the second factor and only the second factor. All primary factor loadings were above 0.70, and loadings onto other factors were no larger than 0.25, most near or below |0.10|. As before, the fear of loss of identity subscale was the least coherent. There were two items which loaded strongly onto the first factor with the fear of loss of control subscale (“disapproval:” loading=0.72; and, “insignificance:” loading=0.73). There was

one item that clearly loaded onto the third factor (“other people’s opinions:” loading=0.88). The remaining items had small and complex loadings. This issue was further demonstrated by interfactor correlations: there was virtually no correlation between the second and third factors (first and second: $r=0.26$; first and third: $r=0.24$; second and third: $r=0.01$).

To further clarify the subscales, the complex loadings here identified were removed (“rejection” from the fear of loss of control subscale, and “disapproval” and “insignificance” from the fear of loss of identity subscale). This did improve overall scale functionality toward a three factor structure. It was only the first three eigenvalues that were larger than one (first eigenvalue=3.46; second eigenvalue=1.90; third eigenvalue=1.23; fourth eigenvalue=0.89). These first three eigenvalues accounted for 55% of the variance. Most importantly, there were clearly three factors before the elbow on the scree plot. Factor loadings for a three-factor solution were mixed. Every item on the fear of loss of control subscale had large loadings onto the second factor, ranging from 0.40 to 0.82, although two items had larger loadings onto the third factor (“weakness:” loading=0.45; “vulnerability:” loading=0.40). The fear of loss of social relations remained strong, with all items loading clearly onto the first factor, with loadings ranging from 0.65 to 0.79. The fear of loss of identity subscale did have two items with strong loadings onto the third factor (“failure:” loading=0.70; “insignificance:” loading=0.79), however one item remained small and indiscriminate (“anonymity,” first factor loading=0.18; second factor loading=0.27; third factor loading=0.26). Interfactor correlations increased, however factor three still had a small correlation (first and second: $r=0.25$; first and third: $r=0.09$; second and third: $r=0.35$).

Because a factor cannot be identified with fewer than three items, no further edits were made. These results demonstrate that the FC needs work. Though the fear of loss of control and fear of loss of social relations scales may provide meaningful results, the fear of loss of identity subscale was consistently troublesome with somewhat low metrics of internal consistency. Individual subscales may be appropriate for use, however using the composite scale to distinguish three forms of existential fear within undergraduates may be unhelpful. If the full scale is to be used, it is advised to use the 15 item scale (where “control” is removed from the control subscale; “honesty” is removed from the social relations subscale; and “success” is removed from the identity subscale). This scale provided more evidence for a three-factor structure than the full scale and though factor loadings were not ideally discriminate, they were simpler in structure than the full scale. Individual subscales for the 15-item scale showed evidence for a single-factor structure and all items had sufficiently large loadings. Lastly, after rounding the 15-item scale had the same value for coefficient omega as the 18-item scale, however before rounding internal consistency increased slightly ($\omega=0.82$). Dropping additional items is not advised for use: factor structure did not simplify and internal consistency for the scale was lower ($\omega=0.71$). These suggestions are reiterated in Table 4.

Ethical Position Questionnaire (EPQ)

The unedited EPQ was one of the most balanced questionnaires analyzed. Internal consistency as a single metric and within subscales was strong but not excessive. The combined metric and the subscale for relativism both provided $\omega=0.88$, while the subscale for idealism provided $\omega=0.86$. Individual item correlations were generally significant and small to moderate, about $r=0.15$ to $r=0.40$ (full range from $r=-$

0.01 to $r=0.83$). The scatter plot between the two subscales was more or less elliptical and demonstrated a clear positive relationship. Participants were advocates of relativism and idealism alike. Though the mean for relativism ($M=5.80$, $SD=1.26$) was larger than the mean for idealism ($M=6.63$, $SD=1.38$), this is not likely a meaningful difference given the wide standard deviation. As could be predicted, the mean for the combined scale was similar to the means for the subscales ($M=6.22$, $SD=1.08$).

Full results of the analysis can be found in Table 5. All items were examined together in one factor analysis before the individual subscales were isolated for more detail. Performing a factor analysis with a promax rotation did demonstrate a two factor structure as expected with some variance remained to be explained. The first four eigenvalues were all above one (first eigenvalue=6.10; second eigenvalue=3.65; third eigenvalue=1.62; fourth eigenvalue=1.31). Although the third and fourth eigenvalues were larger than desired, the first two eigenvalues did explain 49% of the variance and the scree plot clearly showed two factors before the elbow. Examining rotated factor loadings, the idealism subscale was simple in structure. Loadings onto the first factor were generally large (generally around 0.65 to 0.75) and loadings onto the second factor small (generally around 0.00 to |0.10|). The relativity subscale, on the other hand, showed some complexity. There were eight items with strong loadings on the second factor (generally around 0.65 to 0.75) with small loadings on the first factor (generally around |0.05|). That said, there were two items with small loadings onto both factors (“Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes,” first factor loading=0.24, second factor loading=0.13; and, “Whether a lie is judged to be moral or immoral depends upon

the circumstances surrounding the action,” first factor loading=0.33; second factor loading=0.17).

Examining subscales individually was informative, the relativity subscale was considered first. The first eigenvalue was noticeably larger than the rest, though the first two were greater than one (first eigenvalue=3.96; second eigenvalue=1.26). The scree plot was difficult to interpret, as there was a smooth curve without a distinct elbow. That said, the first eigenvalue did account for 50% of the variance, as is desired. Seeing a large first eigenvalue that accounted for half of the variance and theoretical foundation as a one factor subscale, one factor was extracted. Factor loadings were generally large, around 0.60 to 0.80. The indiscriminate loadings from the first analysis of all 20 items were again low (“Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes:” loading=0.22; and, “Whether a lie is judged to be moral or immoral depends upon the circumstances surrounding the action:” loading=0.29). These items were removed and the analysis rerun. This clarified the subscale, with now only the first eigenvalue greater than one (first eigenvalue=4.53; second eigenvalue=0.84) and accounting for the majority of the variance, 57%. The scree plot now showed clearly one factor before a distinct elbow. All factor loadings were greater than 0.58, with most around 0.65 to 0.75. After rounding, coefficient omega for the scale did not change, however it did increase before rounding (omega=0.89). Researcher interested in the EPQ for undergraduates should consider removing the two problematic items.

Next, the idealism subscale was considered. This scale showed greater risk for a two-factor structure than the relativism subscale. Though the first eigenvalue was

distinct, the second eigenvalue was larger than one and fell before the elbow of the scree plot (first eigenvalue=4.62; second eigenvalue=1.41). Additionally, the first factor only accounted for 46% of the variance, slightly less than the 50% cut off suggested by Harlow (2014). The factor pattern seemed appropriate, all loadings greater than 0.50, generally around 0.70 to 0.80. There were two items that were low relative to other items (“People should make certain that their actions never intentionally harm another even to a small degree:” loading=0.50; and, “It is never necessary to sacrifice the welfare of others:” loading=0.53). Though these are not unreasonable values, the loadings were of similar magnitude on the two factor extraction of all 20 items. To eliminate what may be a second factor, they were removed and the analysis rerun. This simplified the scale toward a one factor solution. The first eigenvalue was now the only eigenvalue larger than one (first eigenvalue=4.52; second eigenvalue=0.89), accounting for 56% of the variance, and the only factor falling before the elbow of the scree plot. All factor loadings were at least 0.60, with most around 0.75. Coefficient omega for the scale increased from 0.86 to 0.89. Researchers interested in using the EQP should consider removing the two less central items.

Having identified noisy variables, the analysis was rerun on the 16-item scale (with items “Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes,” and “Whether a lie is judged to be moral or immoral depends upon the circumstances surrounding the action,” removed from the relativism subscale and items “People should make certain that their actions never intentionally harm another even to a small degree,” and “It is never necessary to sacrifice the welfare of others,” removed from the idealism subscale).

A two-factor structure was more apparent. The third eigenvalue was still greater than one, but only marginally so (first eigenvalue=5.68; second eigenvalue=3.41; third eigenvalue=1.07). Furthermore, the first two eigenvalues accounted for 57% of the variance and there were clearly only two factors before the bend of the scree plot. Factor loadings were all simple, primary factor loadings ranging from 0.56 to 0.90 and secondary factor loadings no greater than $|0.10|$. Coefficient omega was unchanged ($\omega=0.88$). The interfactor correlation was moderate ($r=0.23$). Seeing much clearer division of items, researchers interested in discriminating ethical opinions among undergraduates should consider the removal of the four items with lower loadings.

Self-Control Scale (SCS)

The unedited SCS, which did not have subscales, demonstrated appropriate functionality. Internal consistency was somewhat low but within reasonable research limits, providing $\omega=0.72$. Individual item correlations were appropriate, generally between 0.20 and 0.40, with a full range from 0.10 to 0.66. Participants on average had a moderate amount of self-control ($M=3.22$, $SD=0.70$).

Full results can be found in Table 6. The factor analysis was concerning, as there was evidence for as many as three factors in the scale. The first three eigenvalues were all at or above one (first eigenvalue=3.77; second eigenvalue=1.59; third eigenvalue=1.00), and the first eigenvalue only accounted for 38% of the variance. Furthermore, the scree plot demonstrated three factors before the bend. One factor was extracted because the scale was designed to represent the singular concept of self-control. Factor loadings were all appropriate in size, most above 0.50, full range from 0.35 to 0.79. Though this scale may be functional as a one factor metric of self-control, the

lower value of coefficient omega and evidence for multiple factor structure remained a concern. The lowest loading item (“I refuse things that are bad for me, even if they are fun,” loading=0.35) was removed and the analysis rerun.

This improved the factor structure, however there was remaining evidence for a two-factor structure. The first two eigenvalues were both above one (first eigenvalue=3.68; second eigenvalue=1.27) and the first eigenvalue still only accounted for 40% of the variance. The number of factors on the scree plot before the elbow decreased to two, however the scale was designed for a one factor solution. Loadings were similar to as before, all greater than 0.50. The smallest two factors were for the only two items that are not reverse scored (“I’m good at resisting temptation,” loading=0.52; and, “people would say that I have very strong self-discipline,” loading=0.53). This may indicate that there is a measurable difference between the presence of self-discipline and the absence thereof. The analysis was rerun using only the items that were reverse scored, representing a lack of self-discipline.

This change did result in evidence of a one factor structure. The second eigenvalue was slightly above one, but only slightly (first eigenvalue=3.30; second eigenvalue=1.01). More importantly, the scree plot showed clearly one factor before the bend of the elbow. The first factor now accounted for 47% of the variance, and coefficient omega jumped from 0.72 to 0.85. Factor loadings for the simplified scale of lack of self-discipline were all large, ranging from 0.57 to 0.77. It is recommended that researchers interested in the self-control scale be precise in the research question being asked. For researcher specifically interested in the presence of self-control, the full scale may be theoretically more relevant even if less internally consistent. If a more loose

definition of self-control is acceptable, the revised seven-item scale of items reverse scored will likely perform better. The possible changes are reiterated in Table 6.

Aim 2: Personal fulfilment inventory creation

Items selected for all subscales are presented in Appendix C. The pleasurable life subscale was created first. In many cases, it was impossible to find items with large correlations with all items across all four psychological constructs. Correlations between items were generally small to moderate and not always significant, around $r=0.10$ to $r=0.20$. There were three items with slight negative correlations, however two of the negative correlations were close to zero, the third and largest negative correlation was $r=-0.08$ ($p=0.2340$). The largest correlation was $r=0.80$ ($p<0.0001$).

Next, the good life subscale was created. This scale was a little more cooperative: though there was one bivariate correlation at $r=0.00$ ($p=0.9308$), there were no negative correlations. Individual correlations were still small, but closer to $r=0.20$. The largest individual item correlation was smaller than on the pleasurable life subscale ($r=0.54$, $p<0.0001$).

Lastly, the meaning subscale was created. This scale was the least compatible between items. There were nine items with negative bivariate correlations. Seven of these were virtually zero, however there were two that were moderately small ($r=-0.13$, $p=0.0422$; $r=-0.16$, $p=0.0094$). Both of these items were from the FC, specifically the fear of loss of identity subscale, to which major edits were suggested because no items showed simple structure. For this reason, options were limited and item relationships were not always clear. There was a range of item correlations, many fairly small, others moderate in size, most around $r=0.05$ to $r=0.30$. The largest was $r=0.76$ ($p<0.0001$).

Confirmatory factor analysis was performed with each of Winston's (2016) three developmental stages as three separate factors, and covariances between factors were estimated. The loading for one item on each factor was fixed to one. The first model provided an RMSEA just at standard research limits (RMSEA= 0.1002, 90% CI [0.0931, 0.1072]), however the CFI was exceptionally low (CFI=0.47). A review of residuals showed exceptionally large standardized residuals between items from the same original scales (e.g. as large as $\text{psy}(\text{epq2}, \text{epq3})=0.76$). A post hoc adjustment was made to covary errors for items on the same scale (i.e. items on the FNSM were covaried with other items on the FNSM; items on the OTH covaried with other items on the OTH; items on the FC covaried with other items on the FC; items on the EPQ covaried with other items on the EPQ; and items on the SCS covaried with other items on the SCS). Though this may have been a risk of overfitting the model, these items should have had correlated errors because they were from the same questionnaires. Model fit statistics are presented in Table 7 and estimates in Table 8. This change greatly increased model fit, to within acceptable limits (i.e., RMSEA<0.1000, CFI>0.90).

Three models were tested: a correlated model with covariances estimated between all three factors, an orthogonal model with covariances between factors constrained to zero, and a single factor model with covariances between factors constrained to one. The best fitting model was the correlated model. The chi square value was significant ($X^2(466, N=129)=572.4348, p=0.0005$), however the CFI was now clearly within acceptable limits (CFI=0.93), and the RMSEA was the lowest of all models (RMSEA=0.0422, 90% CI [0.0289, 0.0536]). The orthogonal model was the worst fitting model. Though the RMSEA was appropriate (RMSEA=0.0575, 90% CI [0.0472,

0.0672]), the CFI was somewhat low (CFI=0.86). The chi squared value was significantly larger than it was for the correlated model ($\chi^2(3, N=129)=94.92, p<0.0001$) and the change in CFI was significantly lower (change in CFI=0.07).

As its own model, the single factor model was not unreasonable fit. The chi square value was significant, ($\chi^2(469, N=129)=627.36, p<0.0001$), yet the CFI was close to acceptable limits (CFI=0.89), and the RMSEA was appropriate (RMSEA=0.0514, 90% CI [0.0402, 0.0616]). While the single factor model may have been a reasonable standalone model, it had significantly worse metrics of fit than the correlated model across chi squared value ($\chi^2(3, N=129)=54.93, p<0.0001$), CFI (change in CFI=0.04), and RMSEA (change in RMSEA=0.0082). Ultimately, it was the correlated model that was favored.

Examining standardized loadings, most are significant and moderate in size, around 0.30 to 0.40. There were two items with negative loadings, though these were virtually zero and both insignificant (“risks to another should never be tolerated, irrespective of how small the risks might be.” loading=-0.02, $p=0.8078$; and, “the existence of potential harm to others is always wrong, irrespective of the benefits to be gained.” loading=-0.01, $p=0.9251$, both from the EPQ on the meaning subscale). Beyond these two negative loadings, there were three other nonsignificant items (“ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes.” loading=0.08, $p=0.2931$, from the EPQ on the pleasure subscale; “I do things that feel good in the moment but regret later on.” loading=0.11, $p=0.2360$, from the SCS on the good life subscale; and “the dignity and welfare of the people should be the most important concern in any society.”

loading=0.03, $p=0.7421$). The other items were all significant, most at $p<0.0001$. The largest loading was 0.81 ($p<0.0001$, for “I completely accept all aspects of myself,” from the FNSM on the meaning subscale). Internal consistency was strong for the PFI overall ($\omega=0.83$). Though internal consistency was less for individual subscales, it was not unreasonably low (pleasurable life: $\omega=0.69$; good life subscale: $\omega=0.75$; meaningful life subscale: $\omega=0.73$).

The correlated errors led to inflated covariance estimates within the SEM, so bivariate correlations between scales were seen as more interpretable. Correlations between subscales were moderate to large and all significant (pleasure and engagement: $r=0.40$, $p<0.0001$; pleasure and meaning: $r=0.34$, $p<0.0001$; engagement and meaning: $r=0.56$, $p<0.0001$). Additionally, seeing as Winston’s (2016) model is developmental in theoretical organization, correlations were also examined between age and scales of the PFI. Contrary to expectations, correlations were very small and all insignificant (pleasure: $r=-0.05$, $p=0.4636$; engagement: $r=-0.01$, $p=0.8518$; meaning: $r=0.02$, $p=0.7533$). The low correlations could have been due to a somewhat restricted age range in the current sample; this could be tested further in a sample with a more diverse age range.

Lastly, to verify functionality of the scale, multiple regression was used to predict overall life satisfaction as measured by the SWLS. Hierarchical multiple regression was used in three steps, starting with pleasure and adding engagement and then meaning. Results can be found in Table 9. The model only including pleasure was significant ($F(1, 115)=26.2$, $p<0.0001$) and accounted for a moderate amount of the variance (adjusted $R^2=0.18$). The relationship between pleasure and satisfaction was significant ($\beta=-0.43$,

$p < 0.0001$), however in the opposite direction as was expected. There was a moderately large negative relationship between pleasure and satisfaction. Adding engagement, the model was still significant ($F(2, 114) = 27.9, p < 0.0001$), now explaining a large amount of variance (adjusted $R^2 = 0.32$). Both parameters were significant (pleasure: $p = 0.0018$; engagement: $p < 0.0001$). As before, coefficients were negative, engagement predicting less satisfaction than pleasure (pleasure: $\beta = -0.27$; engagement: $\beta = -0.41$). Lastly, meaning was added. The model was virtually unchanged, remaining significant ($F(3, 113) = 19.02, p < 0.0001$) with no change to the amount of variance explained ($R^2 = 0.32$). Parameter estimates for pleasure and engagement shrank slightly, however they were still significant and close to what they previously were (pleasure: $\beta = -0.25, p = 0.0037$; engagement: $\beta = -0.36, p = 0.0003$). The standardized coefficient for meaning was small and nonsignificant ($\beta = -0.10, p = 0.283$), the unstandardized coefficient only slightly larger than its standard error ($B = -0.23, SE = 0.22$). Though this provides some evidence in support of the scale's functionality, the negative coefficients were unexpected and should be examined in further research.

Discussion

The first aim of this analysis was to provide improved metrics for measuring psychological constructs of happiness and development within undergraduate students. Specific scale items and possible edits are reviewed in Table 2 through Table 6. Most scales were reasonable functional. Though items may be considered for removal to improve discriminatory functioning, most scales were appropriate. The FNSM is quite long, clearly unparsimonious and lacking clear factor definition. Though no edits were suggested, tailoring the scale to individual research projects may be worth consideration.

There was some concern that individual subscales of the OTH did not function as expected, suggested edits more or less cleaned up the item ambiguities. The FC was the most concerning scale. As an overall metric of existential fear, the scale was fine. That said, when trying to distinguish individual sources of fear, the scale broke down, especially the fear of loss of identity subscale. The EPQ was the most stable scale. Individual items acted counter to expectations and are suggested to be removed (i.e. “Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes,” and “Whether a lie is judged to be moral or immoral depends upon the circumstances surrounding the action,” from the relativism subscale; and “People should make certain that their actions never intentionally harm another even to a small degree,” and “It is never necessary to sacrifice the welfare of others,” from the idealism subscale), however the scale as a whole showed strong internal consistency. The SCS was of concern. The full scale was reasonably functional, though there was a functional difference between items that measured self-control and items that were reverse scored to measure a lack of self-control. Removing the not-reverse-scored items improved internal consistency of the scale, however this change does change the scale from measuring self-control from multiple angles to measuring specifically a lack of self-control.

The second aim of this analysis was to compile the PFI, a summary scale organized from reviewed questionnaires to measure a broader conception of happiness that transcends and summarizes psychological development. The theoretical foundations for the scale come from Winston (2016), and the scale was intended to measure psychological development along the lines of her theory. The items on the scale were

drawn from existing scales and are provided in Table 7. In terms of the basics, development of this scale was successful. The model fit the data well enough and internal consistency for the scale was appropriate. Some of the subscales had lower internal consistency lower than would have been ideal, however no value was unreasonably small. What was more concerning was the functionality of the scale in context. The theory was inherently developmental by design, yet correlations with age were generally small. A more age-diverse or longitudinal sample would allow a clearer assessment of a developmental aspect.

Specifically, this lack of relationship with age may be because it was assessed within an undergraduate sample. Winston's (2016) theory is developmental, but at the scale of lifespan development. Although the oldest participant was 55 years old, most participants were in their late teens and early 20s. What small correlations could be identified with age were in the directions Winston (2016) would predict. There was a negative relationship with pleasure, meaning that pleasure marginally decreased with age. The weakest relationship was between age and engagement, the middle stage of development. Lastly, there was a positive relationship between age and meaning, meaning that older students experienced happiness as meaning marginally more than younger students.

One possible explanation for these unexpectedly small relationships is that the mechanical driver of development within Winston's (2016) theory is not age, but rather experience. Correlations with the number of years postsecondary education were still small and insignificant, but slightly larger than the correlations with age. The same pattern of results was also identified (i.e., negative correlation with pleasure, positive

correlation with meaning, correlation with engagement between the correlations for pleasure and meaning). This may provide some evidence in support of Winston's (2016) ordering, although further investigation of this is certainly warranted.

The other unexpected result was the relationships between the PFI and life satisfaction. Winston's (2016) theory implies that happiness as meaning is the most satisfying, followed by engagement, and pleasure the least satisfying. This was in some ways confirmed, although not as expected. Rather than participants high in meaning being high in satisfaction, it was the opposite. Participants high in pleasure were low in satisfaction, while there was no significant relationship between meaning and satisfaction. One possible explanation for this is the overall satisfaction among participants. In general, participants reported being quite low in life satisfaction, suggesting that this specific sample may have been particularly unsatisfied in general. It would be stronger evidence in support of Winston's (2016) theory if there were a strong positive relationship between meaning and satisfaction; a weaker relationship between engagement and satisfaction; and the weakest between pleasure and meaning. Meaning being uncorrelated with an unsatisfied sample, and pleasure predicting lack of satisfaction in the same sample is some evidence in support of Winston's (2016) theory.

Though the overall trend that pleasure is the least satisfying and meaning is the most satisfying was evident in the data, it was unexpected that engagement would be the strongest predictor of dissatisfaction in the sample, counter to Winston's (2016) theory. This may be because happiness as engagement as a phenomenon is often at odds with how happiness is often conceptualized. Engagement is the active process of getting lost in an activity, it is defined by being in the moment. Though experiencing engagement

may feel euphoric, it begins and ends at the moment of engagement. It is possible that this experience is not measured by questionnaires as easily as pleasure or meaning because it is such an active process to experience engagement.

Another possible explanation is that this is an error not of measurement but of theory by Winston (2016). A running consideration through the entire analysis is the confounding between scale imperfections and theoretical imperfections by Winston (2016). Winston's (2016) theory was entirely rational in epistemology, therefore the empirical validity of her theory is yet undetermined. At the crux of this dilemma is the naturalistic fallacy: that which is observed is not necessarily that which should be observed (Lapsley, 1996). The PFI was specifically tailored to quantify the theories Winston (2016) describes. It identifies what should be observed according to Winston (2016), which was the goal of creating the scale. The question remains as to what will be observed, whether or not her theory is an accurate representation of development.

For example, suppose that the small correlation with age is taken as a true null relationship with age and the PFI is accepted as an appropriate quantification of her theory. If this is the case, then this lack of correlation with age would indicate that her theory should not be considered developmental. However, at this point, it is uncertain whether or not the PFI can be accepted as a true quantification of Winston's (2016) theory, and the true relationship with age is also undetermined. The goal of this analysis was to identify meaningful question items to quantify her theory. In assessing how well this goal was accomplished, it is unclear whether results counter to expectations are due to errors of the scale or empirical errors of the theory.

This complication directly extends into the issue of insignificant items, especially from the EPQ. All EPQ items on the meaning subscale were insignificant, two loadings even slightly negative. A fourth EPQ item was also insignificant on the pleasure subscale. This could easily be taken as a criticism of the EPQ being irrelevant. This is not the opinion of the researcher. The EPQ had strong metrics of internal consistency and simple structure among item loadings; it was characterized as the most stable of all scales considered. Moreover, there was one item that was not on the EPQ that was insignificant, from the SCS on the engagement subscale. Rather than blaming the EPQ as an inappropriate scale, an alternative interpretation is that it was Kohlberg's (1984) theory, measured by both scales, that was less related to the other theories Winston (2016) discusses.

There is theoretical and empirical support for this interpretation. Firstly, Winston's (2016) argument only draws in Kohlberg's (1984) theory at the end of her analysis. The majority of the theory focuses on Maslow's (1987), Seligman's (2002), and Kierkegaard's (1989) theories as the fundamental underpinnings. Kohlberg's (1984) theory is identified toward the end of the analysis to expand the theory from exclusively affective to ontological. It is argued that these affective transitions are the foundations for a broader sense of perspective. Within Winston's (2016) writing, Kohlberg's (1984) theory is not identified as a central factor, but rather a further extension of the theory. Small and insignificant loadings could have been expected because it is at the fringe of Winston's writing.

It is not only in theory from Winston (2016) that this result can be expected, but it is also predictable given original theory from Kohlberg (1984). The full theory of moral

development Kohlberg (1984) discusses can be expanded into seven stages: two stages for preconventional morality, two stages for conventional morality, two stages for postconventional or principled morality, and one stage of existential pondering. The method for developing the theory relied on quantitative hermeneutics (Kohlberg, 1984; Lapsley, 1996). The linguistic details of how morality was discussed was a central focus in developing the theory.

In distinguishing among the later stages of his theory, a particular focus was placed on distinguishing between stages five and six of principled morality. Stage five morality was characterized as being discussed with the formalities of logic and social contracts, like how John Rawls discusses justice in *A Theory of Justice* (1971). Stage six morality is realized when the formalities of language are lost. Actions are judged good and bad with simplicity and certainty rather than formal logic. This is important because the EPQ is at times wordy and formal. Low, or even negative, factor loadings would be expected among the most morally developed for complex questions as were on the EPQ. All in all, these provide some evidence in support of Winston's (2016) theory, even if not the supporting evidence that was expected to have been identified.

Limitations and future directions

The largest limitation to this analysis was the age of the sample. Winston's (2016) theory was intended as a lifelong developmental theory, yet the sample was predominantly made up of individuals who were in their twenties. Future researchers may want to sample a wider range of ages. Beyond different ages, a stronger analysis of Winston's (2016) theory would be longitudinal. It is predicted that stages develop in a specific order, which was fundamentally untestable within this sample. A cross lagged

panel design would be more apt to examine the specific orderings of stages within Winston's (2016) theory.

Another limitation was the sample itself. Participants provided low values for overall life satisfaction, the implications of which are unclear. If this is taken as a true representation of dissatisfaction within the sample, then the sample may not generalize to other samples of more satisfied participants. If this is taken as an effect of bias in response behavior, then the validity of the factor analyses are uncertain. Though it is unclear what specific ways this impacts interpretation of results, it is certainly a limitation that the sample was so unsatisfied. One remedy would be to resample and attempt to replicate in a future study.

Another limitation is the sample size. Though factor analysis can be performed on as few as 50 participants (Stevens, 1996), a larger sample is preferred, according to Harlow (2014) as large as 200 if not more. The samples here were both larger than 100 which should have been sufficient, however a larger sample would be more reliable. Again, future research should validate these results with larger samples.

Beyond replication, researchers interested in the PFI may also want to consider the ways that scores on the PFI were calculated. Responses were solicited in a variety of ways (i.e. as a Likert scale from 1 to 5; a Likert scale from 1 to 9; as a dichotomous yes or no), a limitation. Furthermore, to account for these different response formats, responses were transformed into percentages, points scored out of points possible (see Appendix B and Appendix C). Though these transformations allow for standardized arithmetic integrating scale responses, it is not standard practice to score questionnaires in this way. Additive and multiplicative transformation are not generally viewed as a risk

to the underlying data distribution (Myers, Well, & Lorch, 2010), although response patterns are likely different across question response formats. Future researchers should consider simplifying and standardizing item response formats.

Outside of statistical limitations within the sample, the theoretical implications are limited to the sample. The sample predominantly identified as white, cisgender, and female, and the data were collected at a New England university. It is well documented that these populations are oversampled, and in many cases do not generalize to other populations (Matsumoto & van de Vijver, 2010). This is especially a concern because the theories in this analysis are all from white researchers of European descent. Though efforts have been made to cross culturally validate individual theories (Avsec, Kavčič, & Jarden, 2016; Gilligan, 1993; Kohlberg, 1984; Lapsley, 1996; Neher, 1991), the whole analysis can be criticized as Eurocentric at the foundation. Future research should examine cross cultural implications and differences.

Conclusion

The goal of this analysis was to refine metrics for measuring deeper metrics of psychological development among fields that are not always empirical. Though there remain concerns about the functionality of individual scales, all scales were quantitatively improved as a result of this analysis. Assessing generalizability and tailoring scales to different populations is certainly warranted, this analysis has provided preliminary evidence as to how these scales function. This analysis sought to create a composite scale in the PFI, and the PFI was created with reasonable internal consistency. Whereas future researchers may want to further examine the empirical validity of Winston's

(2016) theory, this analysis has provided some preliminary results in support of the theory.

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Table 1.
Descriptive statistics

Variable	Mean	SD	Min	Max	Skew	Kurt	Unedited Omega	Edited Omega
Age	20.08	3.30	18.00	55.0 0	6.89	59.77		
Five needs satisfaction measure	3.57	0.52	2.14	4.99	-0.11	0.44	0.97	
Physiological needs	3.41	0.63	1.80	5.00	-0.06	-0.10	0.88	
Safety security needs	3.75	0.58	2.40	5.00	0.08	-0.30	0.89	
Belongingness needs	3.75	0.58	2.40	5.00	0.08	-0.30	0.92	
Esteem needs	3.60	0.68	1.00	5.00	-0.71	1.08	0.95	
Self-actualization needs	3.20	0.80	1.17	5.00	-0.14	-0.21	0.94	
Fear checklist	8.11	3.93	0.00	18.0 0	0.03	-0.34	0.82	0.82
Control	1.57	1.83	0.00	6.00	0.87	-0.48	0.72	0.74
Social relations	3.53	1.75	0.00	6.00	-0.51	-0.68	0.81	0.82
Identity	3.00	1.58	0.00	6.00	-0.16	-0.50	0.59	0.63
Orientations toward happiness	3.53	0.45	1.06	5.00	-0.48	3.43	0.81	0.78
Pleasure	3.64	0.58	1.17	5.00	-0.83	2.48	0.73	0.73
Engagement	3.27	0.55	1.00	5.00	-0.02	1.05	0.70	0.72
Meaning	3.69	0.61	1.00	5.00	-0.63	1.67	0.78	0.79
Ethical position questionnaire	6.22	1.08	2.85	9.00	-0.07	0.36	0.88	0.88
Relativism	5.80	1.26	1.00	9.00	-0.01	1.03	0.89	0.89
Idealism	6.63	1.38	2.20	9.00	-0.62	-0.02	0.86	0.89
Self-control scale	3.22	0.70	1.50	5.00	-0.31	-0.24	0.72	0.85
Personal fulfillment inventory	2.30	0.50	1.76	4.00	-0.16	0.30	0.83	
Pleasure	2.19	0.59	0.63	4.00	0.23	-0.38	0.69	
Engagement	2.48	0.62	1.50	4.00	-0.63	0.21	0.75	
Meaning	2.23	0.61	1.42	4.00	0.01	-0.03	0.73	
Satisfaction with life scale	3.23	1.39	1.00	7.00	0.70	-0.05	0.93	

Table 2.*Five needs satisfaction measure items and loadings*

	<u>Subscales only</u>	<u>All items</u>				
	<u>Factor</u>	<u>Factor</u>				
	1	1	2	3	4	5
<u>Physiological needs</u>						
1. The quality of the food I eat every day	0.74	0.11	-0.12	0.56	0.22	0.15
2. The amount of food that I eat every day	0.69	0.03	0.10	0.55	0.13	0.09
3. The quality of the water I drink every day	0.53	-0.13	-0.24	0.65	0.17	0.13
4. The amount of water that I drink every day	0.65	0.11	-0.02	0.60	0.05	-0.02
5. The amount of heating I have when the weather is cold	0.43	0.02	0.04	0.29	0.42	-0.13
6. The amount of cooling I have when the weather is hot	0.42	0.03	-0.10	0.18	0.51	0.14
7. The quality of the air I breathe every day	0.29	-0.09	0.01	0.05	0.63	0.20
8. The amount of sex I am having	0.34	-0.07	0.08	-0.01	0.05	0.66
9. The quality of sex I am having	0.38	-0.12	0.09	0.11	0.02	0.75
10. Every aspect of my physical health	0.79	0.45	-0.12	0.54	-0.05	0.12
11. The amount of sleep I get to feel thoroughly relaxed	0.71	0.31	-0.07	0.53	-0.07	0.13
12. The quality of sleep I get to feel fully refreshed	0.77	0.36	-0.09	0.61	-0.05	0.01
13. The amount of exercise I get to keep me healthy	0.80	0.23	-0.02	0.65	-0.16	0.12
14. The type of exercise I get to keep my body toned	0.75	0.23	-0.05	0.59	-0.13	0.15
15. My overall physical strength	0.69	0.12	0.01	0.67	-0.25	0.10
<u>Safety-security needs</u>						
1. The quality of the house/apartment I am living in	0.50	0.24	-0.28	0.18	0.53	0.08
2. The space available for me in my house/apartment	0.45	0.08	-0.18	0.35	0.31	0.11
3. How secure I am in my house/apartment	0.43	0.31	-0.04	-0.07	0.50	0.03
4. How safe I am from being physically attacked	0.61	-0.03	0.03	-0.06	0.71	-0.04
5. The safety of my neighborhood	0.54	0.07	-0.12	-0.20	0.80	0.14
6. How safe I am from catching any diseases	0.61	0.35	-0.04	-0.13	0.68	0.10
7. How secure I am from disasters	0.79	-0.01	0.18	0.08	0.71	-0.09

8. How protected I am from dangers in the environment	0.78	0.00	0.19	0.08	0.68	-0.04
9. The protection that the police provide for me	0.77	-0.09	0.19	0.29	0.55	-0.15
10. The protection that the law provides for me	0.70	-0.30	0.27	0.53	0.25	0.00
11. How safe I am from destructive terrorist acts	0.67	-0.22	0.07	0.51	0.34	0.00
12. How safe I am from acts of war	0.57	-0.40	0.16	0.28	0.42	0.04
13. My financial security	0.68	0.00	0.18	0.74	0.11	-0.23
14. My ability to get money whenever I need it	0.67	0.01	0.25	0.67	0.08	-0.29
15. The money I reserved for me to have a secure retirement	0.54	0.04	-0.05	0.71	0.04	-0.12

Belongingness needs

1. The amount of rapport I share with the people I know	0.64	-0.09	0.60	0.20	-0.03	0.02
2. The quality of the relationships I have with my friends	0.78	-0.01	0.75	0.11	-0.04	-0.11
3. The love I receive from my spouse/partner	0.32	-0.12	0.02	0.05	0.02	0.84
4. The intimacy I share with my immediate family	0.67	0.17	0.35	0.18	0.12	0.23
5. The camaraderie I share with my colleagues	0.73	0.02	0.67	-0.06	0.15	0.05
6. How much I am welcomed in my community	0.76	0.11	0.67	-0.05	0.12	-0.02
7. The warmth I share with my relatives	0.74	-0.10	0.56	0.29	0.02	0.22
8. The emotional support I receive from my friends	0.73	0.03	0.80	-0.07	-0.10	-0.12
9. The feeling of togetherness I have with my family	0.73	0.11	0.44	0.33	-0.01	0.22
10. How much I am cared for by my spouse/partner	0.35	-0.04	-0.01	0.00	0.11	0.84
11. The happiness I share with my companions	0.81	0.00	0.62	-0.01	0.09	0.30
12. The sympathy I receive from my confidants	0.78	-0.03	0.79	0.00	-0.06	0.02
13. The enjoyment I share with associates	0.68	0.15	0.59	-0.09	0.24	-0.14
14. The affection shown to me by my friends	0.72	0.06	0.81	-0.12	0.07	-0.25
15. The closeness I feel with my associates	0.75	0.09	0.72	0.02	0.06	-0.14

Esteem Needs

1. The admiration given to me by others	0.75	0.15	0.73	-0.12	-0.10	0.12
2. The honor that many people give me	0.75	0.09	0.76	-0.06	-0.10	0.09
3. How much other people respect me as a person	0.71	0.18	0.67	-0.07	-0.07	0.00

4. The prestige I have in the eyes of other people	0.69	-0.01	0.56	0.20	-0.08	0.24
5. How highly other people think of me	0.76	0.22	0.54	-0.07	0.02	0.14
6. The high esteem that other people have for me	0.80	0.31	0.55	0.02	-0.16	0.12
7. The recognition I receive from various people	0.77	0.27	0.46	-0.04	0.14	0.21
8. The high regard that other people have for me	0.78	0.28	0.44	-0.05	0.07	0.22
9. How much I like the person that I am	0.81	0.67	0.17	-0.06	0.10	0.13
10. How sure I am of myself	0.81	0.67	0.24	-0.17	0.17	0.02
11. How much respect I have for myself	0.81	0.72	0.23	-0.09	-0.03	0.03
12. All the good qualities I have as a person	0.71	0.64	0.14	-0.12	-0.05	0.07
13. My sense of self-worth	0.79	0.68	0.14	-0.10	0.06	0.14
14. The amount of esteem I have for myself	0.79	0.76	0.03	0.03	-0.04	0.13
15. How positive I feel about myself as a person	0.81	0.78	0.04	-0.04	0.12	0.11

Self-actualization needs

1. I am totally comfortable with all facets of my personality.	0.76	0.65	0.17	0.14	-0.19	0.03
2. I feel that I am completely self-fulfilled.	0.77	0.69	0.16	0.07	-0.24	-0.05
3. I am now being the person I always wanted to be.	0.82	0.79	-0.08	0.16	-0.01	-0.04
4. I am finally realizing all of my innermost desires.	0.69	0.64	0.08	0.05	0.04	-0.21
5. I indulge myself as much as I want.	0.56	0.46	0.16	0.05	-0.01	-0.27
6. I am now enjoying everything I ever wanted from my life.	0.83	0.79	-0.02	0.09	0.00	-0.23
7. I completely accept all aspects of myself.	0.80	0.76	0.07	0.04	0.00	0.02
8. My actions are always according to my own values.	0.63	0.64	-0.04	-0.04	0.30	-0.13
9. I am living my life the way I want.	0.86	0.81	-0.04	0.14	0.14	-0.13
10. I do the things I like to do whenever I want.	0.75	0.62	0.00	0.22	0.12	-0.10
11. I am actually living up to all my capabilities.	0.83	0.75	-0.02	0.17	-0.04	-0.17
12. I am living my life to the fullest.	0.85	0.70	0.03	0.22	0.03	-0.04

Note: multiple factor analyses were run. The left most column represents five factor analyses, when each subscale was performed without including other subscale items with a single-factor solution. The column second from the left represents a one-factor solution with all items included, rather than individual subscales isolated in the analysis. Lastly, the five columns on the right represent a five-factor solution with a promax rotation with all items included. The values 1 through 5 column headers represent the factor onto which items are loading. On the left, there were only single-factor solutions, so there

was only one factor onto which items could load. On the right, there was a five-factor solution, so the column headers distinguish the factor onto which items were loading.

Table 3.*Orientations toward happiness questionnaire items and loadings*

	<u>Subscales only</u>		<u>All items</u>					
	<u>Factor</u>		<u>Factor</u>					
	1	1	1	2	3	1	2	3
<u>Pleasure</u>								
3. Life is too short to postpone the pleasures it can provide.	0.62	0.62	0.08	0.54	0.10	0.56	0.09	0.09
8. I go out of my way to feel euphoric.	0.45		-0.11	0.36	0.41			
13. In choosing what to do, I always take into account whether it will be pleasurable.	0.73	0.71	-0.02	0.67	0.15	0.67	0.09	0.04
15. I agree with this statement: “Life is short – eat dessert first.”	0.63	0.64	0.11	0.55	0.02	0.55	-0.01	0.18
16. I love to do things that excite my senses.	0.67	0.71	-0.12	0.78	-0.08	0.79	-0.07	-0.13
18. For me, the good life is the pleasurable life.	0.75	0.78	0.13	0.72	-0.06	0.74	-0.06	0.11
<u>Engagement</u>								
1. Regardless of what I am doing, time passes very quickly.	0.38		0.22	0.24	0.30			
4. I seek out situations that challenge my skills and abilities.	0.65	0.64	0.05	-0.13	0.63	-0.13	0.66	0.04
6. Whether at work or play, I am usually “in a zone” and not conscious of myself.	0.71	0.71	-0.18	0.22	0.69	0.21	0.72	-0.20
7. I am always very absorbed in what I do.	0.71	0.70	-0.02	0.10	0.69	0.14	0.72	-0.08
9. In choosing what to do, I always take into account whether I can lose myself in it.	0.66	0.68	0.08	0.06	0.59	0.08	0.62	0.05
10. I am rarely distracted by what is going on around me.	0.64	0.67	0.12	-0.29	0.64	-0.29	0.65	0.18
<u>Meaning</u>								
2. My life serves a higher purpose.	0.67	0.71	0.57	-0.04	0.37	0.00	0.32	0.59

5. In choosing what to do, I always take into account whether it will benefit other people.	0.60		0.51	0.05	0.19			
11. I have a responsibility to make the world a better place.	0.78	0.77	0.79	0.08	-0.15	0.15	-0.12	0.75
12. My life has a lasting meaning.	0.87	0.88	0.79	0.09	0.14	0.14	0.09	0.80
14. What I do matters to society.	0.65	0.72	0.75	-0.09	-0.09	-0.06	-0.12	0.81
17. I have spent a lot of time thinking about what life means and how I fit into its big picture.	0.48		0.40	0.36	-0.28			

Note: multiple factor analyses were run. The two left most columns represents three factor analyses performed twice. Each subscale was performed without including other subscale items with a single-factor solution in the left most column. After additional subscale items were removed, the analysis was rerun the column second from the left. The third and fourth columns represent a one factor solution with all items included. The third column include all item loadings for all question items, while the fourth column includes item loading after some questions were removed. Lastly, the six columns on the right represent a three-factor solution with a promax rotation with all items included done twice, first with all items included and then with some items removed. The values 1 through 3 column headers represent the factor onto which items are loading. On the left, there were only single-factor solutions, so there was only one factor onto which items could load. On the right, there were three-factor solutions, so the column headers distinguish the factor onto which items were loading.

Table 4.
Fear checklist items and loadings

	<u>Subscales only</u>					<u>All items</u>								
						<u>Factor</u>								
	1	1	1	2	3	1	2	3	1	2	3	1	2	3
<u>Fear of loss of control</u>														
7. Control	0.30		0.01	0.17	0.51									
8. Powerlessness	0.70	0.71	0.63	0.22	-0.32	0.78	0.01	-0.24	-0.02	0.82	-0.15			
9. Inadequacy	0.77	0.78	0.68	0.15	-0.06	0.75	0.06	-0.06	-0.02	0.81	-0.04			
10. Rejection	0.61	0.62	0.66	-0.12	0.16	0.45	-0.01	0.45						
11. Weakness	0.78	0.77	0.71	0.05	0.24	0.60	0.12	0.28	-0.04	0.55	0.45			
12. Vulnerability	0.61	0.61	0.41	0.23	0.04	0.53	0.18	-0.17	0.12	0.40	0.40			
<u>Fear of loss of social relations</u>														
1. Intimacy	0.78	0.79	0.06	0.78	-0.04	0.06	0.77	-0.04	0.79	0.02	-0.01			
2. Honesty	0.45		-0.06	0.17	0.65									
3. Dating	0.77	0.78	0.10	0.71	0.05	0.03	0.75	0.10	0.77	0.07	-0.08			
4. Social relations	0.69	0.69	0.06	0.58	0.21	-0.08	0.71	0.25	0.65	-0.04	0.18			
5. Closeness	0.80	0.81	-0.05	0.81	0.04	0.00	0.80	-0.12	0.79	0.00	-0.05			
6. Commitment	0.74	0.74	-0.08	0.75	0.09	-0.03	0.75	-0.11	0.76	-0.06	-0.02			
<u>Fear of loss of identity</u>														
13. Failure	0.66	0.66	0.56	-0.14	0.16	0.45	-0.06	0.29	-0.10	0.11	0.70			
14. Disapproval	0.83	0.83	0.78	-0.07	-0.10	0.72	-0.13	0.18						
15. Insignificance	0.75	0.75	0.72	0.05	-0.13	0.73	-0.04	0.06						
16. Other people's opinions	0.44	0.44	0.36	-0.30	0.51	-0.10	0.05	0.88	0.03	-0.24	0.79			
17. Success	-0.01		-0.16	0.10	0.73									
18. Anonymity	0.34	0.34	0.25	0.21	0.38	0.17	0.36	0.18	0.18	0.27	0.26			

Note: multiple factor analyses were run. The two left most columns represents three factor analyses performed twice. Each subscale was performed without including other subscale items with a single-factor solution in the left most column. After additional subscale items were removed, the analysis was rerun the column second from the left. The third and fourth columns represent a one factor solution with all items included. The third column include all item loadings for all question items, while the fourth column includes item loading after some questions were removed. Lastly, the nine columns on the right represent a three-factor solution with a promax rotation with all items included performed three times, first will all items included and then with increasingly many items removed. The values 1 through 3 column headers represent the factor onto which items are loading. On the left, there were only single-factor solutions, so there was only one factor onto which items could load. On the right, there were three-factor solutions, so the column headers distinguish the factor onto which items were loading.

Table 5.*Ethics position questionnaire items and loadings*

	<u>Subscales only</u>		<u>All items</u>			
	<u>Factor</u>		<u>Factor</u>			
	1	1	1	2	1	2
<u>Moral relativism</u>						
11. There are no ethical principles that are so important that they should be a part of any code of ethics.	0.69	0.69	0.05	0.68	0.68	0.04
12. What is ethical varies from one situation and society to another.	0.76	0.77	-0.02	0.77	0.78	-0.02
13. Moral standards should be seen as being individualistic; what one person considers to be moral may be judged to be immoral by another person.	0.86	0.87	-0.06	0.88	0.89	-0.06
14. Different types of morality cannot be compared as to "rightness."	0.77	0.79	-0.02	0.79	0.79	0.00
15. Questions of what is ethical for everyone can never be resolved since what is moral or immoral is up to the individual.	0.83	0.84	0.00	0.84	0.83	0.02
16. Moral standards are simply personal rules that indicate how a person should behave, and are not to be applied in making judgments of others.	0.80	0.81	-0.03	0.81	0.81	-0.02
17. Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes.	0.22		0.24	0.13		
18. Rigidly codifying an ethical position that prevents certain types of actions could stand in the way of better human relations and adjustment.	0.64	0.62	0.08	0.61	0.60	0.06
19. No rule concerning lying can be formulated; whether a lie is permissible or not permissible totally depends upon the situation.	0.60	0.58	0.13	0.55	0.56	0.08
20. Whether a lie is judged to be moral or immoral depends upon the circumstances surrounding the action.	0.29		0.33	0.17		
<u>Moral idealism</u>						
1. People should make certain that their	0.50		0.56	-0.09		

actions never intentionally harm another even to a small degree.

2. Risks to another should never be tolerated, irrespective of how small the risks might be.	0.75	0.74	0.73	0.00	-0.01	0.75
3. The existence of potential harm to others is always wrong, irrespective of the benefits to be gained.	0.72	0.74	0.72	0.03	0.00	0.74
4. One should never psychologically or physically harm another person.	0.70	0.72	0.66	0.11	0.09	0.70
5. One should not perform an action which might in any way threaten the dignity and welfare of another individual.	0.85	0.87	0.85	-0.07	-0.09	0.90
6. If an action could harm an innocent other, then it should not be done.	0.76	0.77	0.76	0.02	0.01	0.77
7. Deciding whether or not to perform an act by balancing the positive consequences of the act against the negative consequences of the act is immoral.	0.78	0.82	0.76	0.04	0.01	0.81
8. The dignity and welfare of the people should be the most important concern in any society.	0.74	0.73	0.71	0.10	0.10	0.70
9. It is never necessary to sacrifice the welfare of others.	0.53		0.56	-0.10		
10. Moral behaviors are actions that closely match ideals of the most “perfect” action.	0.63	0.60	0.63	-0.02	-0.01	0.60

Note: multiple factor analyses were run. The two left most columns represents two factor analyses performed twice. Each subscale was performed without including other subscale items with a single-factor solution in the left most column. After additional subscale items were removed, the analysis was rerun the column second from the left. The third and fourth columns represent a one factor solution with all items included. The third column include all item loadings for all question items, while the fourth column includes item loading after some questions were removed. Lastly, the four columns on the right represent a two-factor solution with a promax rotation with all items included done twice, first with all items included and then with some items removed. The values 1 and 2 column headers represent the factor onto which items are loading. On the left, there were only single-factor solutions, so there was only one factor onto which items could load. On the right, there were two-factor solutions, so the column headers distinguish the factor onto which items were loading.

Table 6.*Self-control scale items and loadings*

		<u>Factor</u>	
	1	1	1
1. I have a hard time breaking bad habits.*	0.59	0.61	0.61
2. I get distracted easily.*	0.57	0.57	0.57
3. I say inappropriate things.*	0.52	0.54	0.59
4. I refuse things that are bad for me, even if they are fun.	0.35		
5. I'm good at resisting temptation.	0.57	0.52	
6. People would say that I have very strong self-discipline.	0.57	0.53	
7. Pleasure and fun sometimes keep me from getting work done.*	0.61	0.62	0.66
8. I do things that feel good in the moment but regret later on.*	0.79	0.79	0.77
9. Sometimes I can't stop myself from doing something, even if I know it is wrong.*	0.77	0.79	0.82
10. I often act without thinking through all the alternatives.*	0.69	0.71	0.74

**Item is reverse scored*

Note: three factor analyses were run, each with a single-factor solution. Each column represents a different factor analysis with increasingly many items removed.

Table 7.*Confirmatory factor analysis model fit*

Model	df	χ^2	CFI	RMSEA	RMSEA 90%CI LL	RMSEA 90%CI UL	Δ df	$\Delta \chi^2$	Δ CFI	Δ RMSEA
3	466	572.43*	0.93	0.0422	0.0289	0.0536				
2	469	627.36**	0.89	0.0514	0.0402	0.0616	3	54.93**	0.04*	0.0082
1	469	667.35**	0.86	0.0575	0.0472	0.0672	3	94.92**	0.07*	0.0153

Note: Model 1 is a correlated model where factor covariances are freely estimated; model 2 is a one factor model where factor covariances are constrained to one; and model 3 an orthogonal model where factor covariances are constrained to zero.

** $p < 0.05$*

*** $p < 0.0001$*

Table 8.
Personal fulfilment inventory items and loadings

	Standardized loading	SE	Z	p
Pleasurable life:				
The quality of sleep I get to feel fully refreshed	0.30	0.09	3.19	0.0014
My financial security	0.36	0.09	3.97	<0.0001
My ability to get money whenever I need it	0.25	0.10	2.57	0.0100
In choosing what to do, I always take into account whether it will be pleasurable**	0.40	0.09	4.60	<0.0001
I love to do things that excite my senses	0.33	0.09	3.70	0.0002
For me, the good life is the pleasurable life	0.40	0.09	4.58	<0.0001
Powerlessness	0.35	0.09	4.01	<0.0001
Inadequacy	0.32	0.09	3.67	0.0002
Weakness	0.22	0.09	2.44	0.0148
Moral standards are simply personal rules that indicate how a person should behave, and are not be applied in making judgments of others	0.30	0.08	3.71	0.0002
Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes	0.08	0.08	1.05	0.2931
Rigidly codifying an ethical position that prevents certain types of actions could stand in the way of better human relations and adjustment	0.07	0.03	2.41	0.0161
Good life:				
The quality of the relationships I have with my friends	0.37	0.09	4.16	<0.0001
How highly other people think of me	0.50	0.08	6.18	<0.0001
My sense of self-worth	0.52	0.08	6.56	<0.0001
Whether at work or play, I am usually “in a zone” and not conscious of myself**	0.47	0.08	6.05	<0.0001
I am always very absorbed in what I do	0.28	0.09	3.12	0.0018
I am rarely distracted by what is going on around me	0.46	0.08	5.78	<0.0001
Intimacy	0.30	0.09	3.43	0.0006
Social relations	0.40	0.08	4.88	<0.0001
Closeness	0.38	0.08	4.59	<0.0001
I have a hard time breaking bad habits*	0.41	0.08	5.02	<0.0001
I get distracted easily*	0.21	0.09	2.35	0.0185
I do things that feel good in the moment but regret later on*	0.11	0.09	1.19	0.2360
Meaningful life:				
I am totally comfortable with all facets of my personality	0.68	0.07	9.72	<0.0001
I am finally realizing all of my innermost desires	0.69	0.07	9.74	<0.0001
I completely accept all aspects of myself**	0.81	0.06	14.23	<0.0001
My life serves a higher purpose	0.32	0.09	3.63	0.0003
My life has a lasting meaning	0.51	0.07	6.82	<0.0001
What I do matters to society	0.43	0.08	5.27	<0.0001

Failure	0.38	0.08	4.49	<0.0001
Disapproval	0.34	0.09	3.98	<0.0001
Other people's opinions	0.42	0.08	5.09	<0.0001
Risks to another should never be tolerated, irrespective of how small the risks might be	-0.02	0.10	-0.24	0.8078
The existence of potential harm to others is always wrong, irrespective of the benefits to be gained	-0.01	0.10	-0.09	0.9251
The dignity and welfare of the people should be the most important concern in any society	0.03	0.09	0.33	0.7421
<i>*Item is reverse scored</i>				
<i>**Item loading was constrained to one</i>				

Table 9.*Multiple regression analysis of Winston's (2016) theory predicting life satisfaction*

Model	df	F	p	Adjusted R ²	Predictor	B	SE	β	<i>p</i>
1	1, 115	26.2	<.0001	0.1785	Pleasure	-1.05	0.21	-0.43	<.0001
2	2, 114	27.9		0.3169	Pleasure	-0.65	0.20	-0.27	0.0018
					Engagement	-1.03	0.21	-0.41	<.0001
3	3, 113	19.02	<.0001	0.3179	Pleasure	-0.61	0.21	-0.25	0.0037
					Engagement	-0.90	0.24	-0.36	0.0003
					Meaning	-0.23	0.22	-0.10	0.2830

Figure 1.
Conceptual diagram from Winston's (2016)

Figure 1. The role of need deprivation–gratification in conceptualizations of an ideal life.

Figure 2.

Matrix of developmental stages and psychological constructs

		Developmental theories			
		Maslow's hierarchy of needs	Seligman's authentic happiness	Kierkegaard's existential despair	Kohlberg's moral development
Winston's developmental stages	The pleasurable life	Physiological and safety-security needs	Pleasure	Despair to not have a self	Preconventional morality
	The good life	Belongingness and esteem needs	Engagement	Despair to not be oneself	Conventional morality
	The meaningful life	Self-actualization needs	Meaning	Despair to be oneself	Principled morality

Appendix A.

Additional detail on Winston's (2016) theory

Winston's (2016) theory seeks to simplify and integrate similar theories across epistemologies. It brings together findings within humanism, existentialism, and positive psychology to propose a more basic developmental process that gives rise to similar theories within these disciplines. At the base of the theory is humanistic need satisfaction as defined by Maslow (1987). Five groups of needs are described: physiological needs, safety security needs, belongingness needs, esteem needs, and self-actualization needs. Physiological needs are described as the most basic needs, including nutrition, air to breathe, and sleep. Safety security needs are the next level of humanistic development, emphasizing personal safety and secure housing. Belongingness needs are the first to enter the realm of the psychological. They are characterized by having a supportive community of friends and family. The fourth level of Maslow's (1987) hierarchy is esteem needs, which is characterized by feeling a sense of capability and accomplishment. The final stage of humanistic development is composed of self-actualization needs, which include a sense of purpose and personal fulfillment.

Winston argues that based on need gratification, affective environment is determined. On the surface this is happiness as described by Seligman (2002), however it is shadowed by despair as described by Kierkegaard (1989). Seligman's (2002) forms of happiness, as discussed elsewhere, are pleasure, engagement and meaning. Pleasure is a feeling of joy, engagement is task based focus, and meaning is deep connection to broader things.

Kierkegaard's (1989) despair is discussed in terms of denial of unpleasant truths about the self. Three varieties of despair are described: despair to not have a self, despair

to not be oneself, and despair to be oneself. The least conceptually developed, despair to not have a self represents no awareness beyond what is immediately relevant. There is no awareness of who one is, just immediate desires and disappointments. Despair to not be oneself is described as awareness of and resentment of who an individual is. This despair is especially social: similar to Freudian theory, ego ideals are sought to resolve personal discontent with who the individual is. A sense of self extends to others to account for personal limitations. Lastly, despair to be oneself is described as the ultimate realization of existential isolation. At this stage, the individual accepts who they are as who they are, though they regret that they are only one person. This is the most honest stage of development, where there is no denial of self but rather sadness at what that honesty entails. It is a mix of personal acceptance and defeat that personhood is limited.

Winston (2016) goes a step further to suggest that these developmental processes are not simply affective, but ontological. It is argued that in these personal transitions, perspective on justice and morality is developed, specifically as described by Kohlberg's (1984) theory of moral development. The first stage of moral development discussed by Kohlberg (1984) is preconventional morality. Moral opinions are selfish and short sighted. There is no sense of equitable justice, morality is instead determined by power and whether or not one can "get away" with a behavior. The second stage of moral development is conventional morality. Moral action is described as stereotyped, based on ethical prototypes to be a good friend and citizen. Rather than justifying behavior with underlying ethical reasoning, conventions are prioritized. The final stage of moral development is called alternatively postconventional and principled morality. The emphasis here is placed on deeper themes of fairness and justice, specifically as discussed

by John Rawls in *A Theory of Justice* (1971). A behavior is not justified because an individual is powerful enough to get away with it. Neither is a behavior justified because others perform the behavior. A behavior justified if and only if it is morally right.

Winston's (2016) theory collapses across these domains to suppose a three stage developmental process underpinning all four constructs. Three lives are hypothesized: the pleasant life, the good life, and the meaningful life. The pleasant life is the most basic, with only physiological and safety security needs being met. Depraved conditions lead to a desire for escape, denial, and selfishness. Specifically, gratification of these most basic needs leads to happiness as pleasure, despair to not have a self, and preconventional morality.

Once the most basic needs of life are gratified, the good life is realized. Humanistic development progresses to belongingness and esteem needs, having to and offering expertise to a community. There is a motivational drive away from selfishness, however the deeper importance of selflessness is yet to be fully appreciated. The logistics of selflessness are prioritized over the reasons for being selfless. Specifically, this means happiness as engagement, despair to not be oneself, and conventional morality.

Finally, the meaningful life is arises with gratification of the deepest humanistic needs and self-actualization. There is an appreciation for the big picture of life, and identification of how the individual plays a role in it. A sense of good and bad is lost, life is taken as it is with emotional complexity and depth. Specifically, self-actualization needs come with happiness as meaning, despair to be oneself, and principled morality.

Appendix B.

Additional detail on development of the personal fulfilment inventory

There are four psychological constructs within Winston's (2016) theory: Maslow's (1987) hierarchy of needs, measured by the FNSM; Seligman's (2002) personalities of happiness, measured by the OTH; Kierkegaard's (1989) despair, measured by the FC; and Kohlberg's (1984) morality, measured by the EPQ and SCS. The FNSM and OTH were selected because they are measures specifically developed for the purpose of quantifying these theories. The FC was not developed to measure Kierkegaard's (1989) despair, however its three subscales are conceptually relevant. The EPQ was not developed to measure Kohlberg's (1984) morality, however its two subscales are conceptually relevant to preconventional and postconventional morality. Likewise, neither was the SCS developed for measuring Kohlberg's (1984) morality, however it is conceptually relevant to conventional morality. Beyond theoretical relevance, the EPQ and SCS have been identified as predictive of morality as defined by Kohlberg (1984; Hartman, Fok, & Zee, 2009; Heilbrun & Georges, 2011).

There are also three stages as described by Winston (2016): the pleasurable life, stage one for the previously described psychological constructs; the good life, stage two for the previously described psychological constructs; and the meaningful life, stage three for the previously described psychological constructs. Seeing a three by four matrix of theoretical relationships, there are twelve cells representing each specific psychological construct at each of Winston's (2016) three stages. Because a factor requires at least three items to be identified, 36 items total will be considered for the PFI, three for each of twelve cells.

The PFI will be created one subscale at a time. The pleasurable life will be created first. Items will be selected from subscales that Winston (2016) suggested represent the pleasurable life (i.e., physiological needs and safety needs from the FNSM, pleasure from the OTH, fear of loss of control from the FC, and relativism from the EPQ). The same procedure will be used to create a subscale for the good life (composed of items including the belongingness needs and esteem needs from the FNSM, engagement from the OTH, fear of loss of social relations from the FC, and the reverse scored SCS). Lastly, this procedure will be used to create a subscale for the meaningful life (composed of items including the self-actualization needs from the FNSM, meaning from the OTH, fear of loss of identity from the FC, and idealism from the EPQ). Items that correlate with each other and have theoretical relevance to the underlying constructs will be selected for inclusion.

Scoring of the PFI will be based on percentages. Because scales are measured at different levels (i.e., binary, Likert scale 1 to 5 or 1 to 9), the constructs within each subscale will be calculated as a percentage, the number of points observed divided by the number of points possible. Constructs scores will range from 0 (representing no experience of this construct) to 1 (representing full experience of this construct). Each of Winston's (2016) four constructs will then be added together as a measure of personal fulfilment. Though individual construct score will range from 0 to 1, the final scale will range from 0 (representing low fulfilment) to 4 (representing high fulfilment) for each of Winston's (2016) developmental stages.

Here is an example of scoring for the pleasure subscale. The FNSM construct is rated out of 5, so three items rated out of 5, there will be 15 points possible. As such, the

summed score for the three FNSM items would be added, with a possible range from 3 to 15. That said, before dividing, to allow for a response of true 0, scores must be centered. So 3 is subtracted from the summed score and this is divided by the adjusted total points possible, 12. The same would be done for the OTH, which is also rated out of 5. The OTH range original range would be from 3 to 15, subtracting 3 to account for true 0 the adjusted range would be from 0 to 12. The calculation would be the sum total value for the OTH minus 3 all divided by 12. The FC portion, on the other hand, is made up of binaries, so the sum total score for the three FC items would be divided by 3. No centering is necessary because “no” is represented by 0. Lastly, the EPQ is rated out of 9 points or 27 possible points. The original range would be from 3 to 27, subtracting 3 to allow for a true 0 gives an adjusted range of 0 to 24. Scoring would be the sum total of the EPQ minus 3 divided by the adjusted total possible, 24.

This approach extends to the meaning subscale and the engagement subscale, however it should be noted that the engagement subscale includes items from the SCS, rated out of 5. As such, for the SCS construct within the engagement subscale, the final sum of three items should be divided by 12 instead of 24 as was done with the EPQ. So for the SCS, it would be sum total score minus 3 divided by the adjusted total possible points, 12. These instructions will be presented in more detail at presentation of PFI items when created, reported in Appendix A. The following equations can be used to obtain correct values:

$$\begin{aligned} \text{Pleasure} &= ((\text{FNSMp1} + \text{FNSMp2} + \text{FNSMp3} - 3) / 12) + ((\text{OTHp1} + \text{OTHp2} + \text{OTHp3} - 3) / 12) + \\ &\quad ((\text{FCp1} + \text{FCp2} + \text{FCp3}) / 3) + ((\text{EPQp1} + \text{EPQp2} + \text{EPQp3} - 3) / 27) \\ \text{Engagement} &= ((\text{FNSMe1} + \text{FNSMe2} + \text{FNSMe3} - 3) / 15) + ((\text{OTHe1} + \text{OTHe2} + \text{OTHe3} - 3) / 15) + \end{aligned}$$

$$((FCe1+FCe2+FCe3)/3)+((SCS1+SCS2+SCS3-3)/15)$$

$$\text{Meaning} = ((FNSMm1+FNSMm2+FNSMm3-3)/15) + ((OTHm1+OTHm2+OTHm3-3)/15) +$$

$$((FCm1+FCm2+FCm3)/3) + ((EPQm1+EPQm2+EPQm3-3)/27)$$

Appendix C.

Personal fulfilment inventory questions and scoring

1). Need satisfaction

Indicate how much you agree with the statement “I am completely satisfied with” (the items in the list) on a scale ranging from 1 (strongly disagree) to 5 (strongly agree).

a). The quality of sleep I get to feel fully rested.

1 2 3 4 5

b). My financial security.

1 2 3 4 5

c). My ability to get money whenever I need it.

1 2 3 4 5

d). The quality of the relationships I have with my friends.

1 2 3 4 5

e). How highly other people think of me.

1 2 3 4 5

f). My sense of self-worth.

1 2 3 4 5

g). I am totally comfortable with all facets of my personality.

1 2 3 4 5

h). I am finally realizing all of my innermost desires.

1 2 3 4 5

i). I completely accept all aspects of myself.

1 2 3 4 5

2). Happiness

Indicate how much you agree or disagree that the items describe you using a 5-point scale ranged from 1 (strongly disagree) to 5 (strongly agree).

a). My life serves a higher purpose.

1 2 3 4 5

b). I seek out situations that challenge my skills and abilities.

1 2 3 4 5

c). I am always very absorbed in what I do.

1 2 3 4 5

d). I am rarely distracted by what is going on around me.

1 2 3 4 5

e). My life has lasting meaning.

1 2 3 4 5

f). In choosing what I do, I always take into account whether it will be pleasurable.

1 2 3 4 5

g). What I do matters to society.

1 2 3 4 5

h). I love to do things that excite my senses.

1 2 3 4 5

i). For me, the good life is the pleasurable life.

1 2 3 4 5

3). Fears

Please state whether you fear the following.

a). Intimacy

Yes No

b). Social relations

Yes No

c). Closeness

Yes No

d). Powerlessness

Yes No

e). Inadequacy

Yes No

f). Weakness

Yes No

g). Failure

Yes No

h). Disapproval

Yes No

i). Other people's opinions

Yes No

Note: for the purposes of scoring, let "Yes" be represented by 1, and "No" be represented by 0.

4). Morality

Please indicate if you agree or disagree with the following items. Each represents a commonly held opinion and there are no right or wrong answers. We are interested in your reaction to such matters of opinion. Rate your reaction to each statement by writing a number to the left of each statement where:

- 1 = Completely disagree
- 2 = Largely disagree
- 3 = Moderately disagree
- 4 = Slightly disagree
- 5 = Neither agree nor disagree
- 6 = Slightly agree
- 7 = Moderately agree
- 8 = Largely agree
- 9 = Completely agree

___ a). Risks to another should never be tolerated, irrespective of how small the risks might be.

___ b). The existence of potential harm to others is always wrong, irrespective of benefits to be gained.

___ c). It is never necessary to sacrifice the welfare of others.

___ d). Moral standards are simply personal rules that indicate how a person should behave, and are not to be applied in making judgements of others.

___ e). Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes.

___ f). Rigidly codifying an ethical position that prevents certain types of actions could stand in the way of better human relations and adjustment.

Please read the following statements and for each check the box that best represents you.

	Not at all like me	A little like me	Somewhat like me	Mostly Like me	Very much like me
g). I have a hard time breaking bad habits.					
h). I get distracted easily.					
i). I do things that feel good in the moment but regret later on.					

Scoring:

For section 3, fear, represent “no” with 0, and “yes” with 1.

There can be considered three levels of scoring: cellular scoring, construct scoring, and developmental scoring. There will be as many as 12 cellular scores, one for each cell of the matrix in Figure 2. Respondents will receive a score from 0 (representing no experience of this construct) to 1 (representing full experience of this construct).

Additionally, the scale can be scored as individual constructs, the four columns of Figure 2. For a short assessment of need satisfaction, simply add the items scores for section 1. For a short assessment of happiness, simply add the item scores for section 2. For a short assessment of fear, simply add the item scores for section 3. For a short assessment of morality, simply use the following equation:

$$\text{Morality} = (4a + 4b + 4c + 4d + 4e + 4f) + ((4g + 4h + 4i) * 9/5)$$

Scores would range based on their original scale measures. Humanistic need satisfaction would range from 9 (representing no need satisfaction) to 45 (representing satisfaction of all needs). Happiness would range from 9 (representing no feelings of positive affect) to 45 (representing feelings of diverse positive affect). Fear would range from 0 (representing no existential fears) to 9 (representing many existential fears). Lastly, morality would range from 9 (representing no sense of moral justice) to 45 (representing complex sense of moral justice).

Lastly, scoring can represent development as defined by Winston (2016), the three rows of Figure 2. For scoring the PFI, place individual item scores into the following equations:

$$\text{Pleasure} = ((1a + 1b + 1c - 3)/12) + ((2a + 2b + 2c - 3)/12) + ((3a + 3b + 3c)/3) + ((4a + 4b + 4c - 3)/27)$$

$$\text{Engagement} = ((1d + 1e + 1f - 3)/15) + ((2d + 2e + 2f - 3)/15) + ((3d + 3e + 3f)/3) + ((4g + 4h + 4i - 3)/15)$$

$$\text{Meaning} = ((1g + 1h + 1i - 3)/15) + ((2g + 2h + 2i - 3)/15) + ((3g + 3h + 3i)/3) + ((4d + 4e + 4f - 3)/27)$$

Scores would range from 0 (representing low fulfilment) to 4 (representing high fulfilment) on each of Winston’s (2016) three developmental stages.

Manuscript 2

Epigenetic Underpinnings of Happiness

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Abstract

There have long been considered connections between happiness, physical health, and genetics (Abdel-Khalek, 2006; Cohen & Pressman, 2006; Diener, Lucas, & Scollon, 2006; Fredrickson, 2013a; Lyubomirsky, 2007; 2013; Newman, 2011; Pressman & Cohen, 2005; Post, 2005). Despite the strength of these relationships, research in molecular genetics has not been successful at fully explaining these relationships (Nes & Røysamb, 2017). This analysis seeks to identify a plausible developmental pathway from genetic physiology to happiness as a subjective phenomenon. A sample of 10 undergraduate students and 10 graduate students at the University of Rhode Island were used to examine the relationships between epigenetic expression, biomarkers of stress, and experienced happiness. Canonical correlation was used to examine underlying patterns between a set of variables representing subjective happiness and a set of variables representing physiology. Happiness was theoretically defined by Christine Winston (2016) and operationalized by Tanzer et al. (manuscript 1) as an expanded adaptation of Martin Seligman's (2002) three authentic happiness lives. Global DNA methylation was quantified as a marker of epigenetic modification, as well as cortisol and interleukin-6 as markers of physiological stress response. The analysis was significant, and correlations between variables and theoretical implications are considered.

Keywords: Authentic happiness, epigenetics, cortisol, interleukin-6

Introduction

Research into happiness has identified a close relationship between happiness and physical health. Positive affect has been generally described as a protective factor against illness (Abdel-Khalek, 2006; Cohen & Pressman, 2006; Diener, Lucas, & Scollon, 2006;

Fredrickson, 2013a; Newman, 2011; Pressman & Cohen, 2005; Post, 2005). A significant association was identified between the number of positive words used in autobiographies and life expectancy (Danner, Snowdon, & Friesen, 2001). An experimental controlled study found exercise increases happiness (Yook, Kang, & Park, 2017). In an international sample, health behaviors (i.e., physical activity, eating habits) associated with subjective happiness (Peltzer, Pengpid, Sodi, & Mantilla Toloza, 2017). Conversely, negative affect has been specifically identified as a risk factor for diseases including diabetes (DeSteno, Gross, & Kubzansky, 2013), heart disease (Boehm & Kubzansky, 2012; Hackett & Steptoe, 2016; Sin, 2016; Trudel-Fitzgerald, Chen, Singh, Okereke, & Kubzansky, 2016; Trudel-Fitzgerald, Gilsanz, Mittleman, & Kubzansky, 2015), stroke (Barlinn, Kepplinger, Puetz, Illigens, Bodechtel, & Siepmann, 2015), and obesity (Hackett & Steptoe, 2016). It has been suggested that happiness has such an effect on health that it should be taken into consideration by public health researchers (Graham, 2008).

The physiological origins of happiness have been considered in relation to genetics to contradictory results. Early within-subjects research on happiness identified construct stability over time, which has been attributed to an effect of genetics (Lyubomirsky, 2007; 2013). Furthermore, twin studies have suggested heritability rates for happiness ranging from 30-80%. That said, when trying to identify molecular pathways to happiness, there has been little success (Nes & Røysamb, 2017). The goal of this analysis will be to bridge this gap between behavioral and molecular genetic findings regarding happiness.

To provide theoretical framework connecting behavior to physiology, it is worth considering Gilbert Gottlieb's (2007) probable epigenesis theory. In an effort to contextualize gene environment interactions, four strata are defined: genetic, neural, behavioral, and environmental. Personal development is understood as a graded process between intertwined feedback pathways. The strata encompass that which is uniquely personal and physiological (i.e., individual genetics and nervous system wiring) and that which entirely contextual (i.e. behavior and environmental). Moreover, these four strata each interact and shape adjacent strata. Neural networks are founded by individual genetics, and give rise to behaviors. Behaviors are socially determined by contextual environment, but physiologically underpinned by neural systems. Even the extremes of Gottlieb's (2007) theory are subject to feedback. Behaviors shape the environments we live in, and individual genetic code can be "turned on" or "turned off" through epigenetic modification.

This theory is helpful in structuring the relationship between happiness and genetics because no two strata are so far apart that they are mechanically unrelated. This is a possible reason for mixed results between behavioral and molecular geneticists. Twin studies did not account for physiology at all, assuming statistically isolated relationships are genetic underpinnings to happiness. Conversely, molecular geneticists have studied happiness from the perspective of psychopathology, which modern happiness researchers generally do not view as the same thing as happiness (Gable & Haidt, 2005; Nes & Røysamb, 2017). Each side prioritizes one part of Gottlieb's (2007) framework without accounting for the whole system. This analysis will consider the place of happiness within Gottlieb's (2007) contextual framework.

Before identifying specific aims and hypotheses, it is important to review how happiness is defined. An important theory in the study of happiness is authentic happiness theory from positive psychology's founder Martin Seligman (2002). This theory supposes three fundamental approaches to happiness: happiness as pleasure, happiness as engagement, and happiness as meaning. Pleasure is defined as hedonistic joy, fun and laughs. Engagement is defined as intent focus on a task such that time stands still. Meaning is defined as a euphoric sense of fulfillment due to a connection to something broader than the self. From here, these forms of happiness have been used to predict various psychological outcomes (Peterson, Park, & Seligman, 2005; Gander, Proyer, & Ruch, 2016; Vella-Brodrick, Park, & Peterson, 2009).

Though Seligman's (2002) theory has been well received, it has been criticized as shallow. Even Seligman (2012) himself ultimately abandoned the theory for well-being theory, which broadens scope to consider happiness within a broader public health context. Christine Winston (2016), on the other hand, sought to ground Seligman's (2002) theory by providing a more personal psychological context for happiness. She synthesizes theories within the history of developmental psychology to create the existential-humanistic-positive theory of motivation. The refined theory places happiness as an emergent quality of greater life transitions based on need gratification. Happiness is identified as one facet of worldview, which also includes existential despair and sense of moral justice.

The goal of this analysis is to consider the credibility of happiness as a central function of broader human functioning. An often inherited view of happiness is as a simple, state-based emotion; a basic feeling (Diener, 2000; Phillips, De Freitas, Mott,

Gruber, & Knobe, 2017; Jatupaiboon, Pan-ngum, & Israsena, 2013). Seeing close relationships between happiness and physiological health, as well as happiness and broad aspects of psychological development, then it would seem that happiness has deeper connections to human functioning than emotional value alone. This analysis will seek to identify some of the processes by which happiness operates within people. Which is the best way to understand happiness: as an isolated emotion separated by mind-body dualism, the received theory; or as one aspect of a larger bodily monism, the hypothesized theory?

Aims and hypotheses

There are two aims for this analysis: to assess possible physiological underpinnings of happiness, and to consider the aptitude of Winston's (2016) theory within that framework. In considering physiological underpinnings, one epimarker and two biomarkers will be considered: global DNA methylation, interleukin-6, and cortisol. The epimarker, global DNA methylation, was selected because it is a fundamental mechanic by which epigenetic modification is enacted (Kurdyukov & Bullock, 2016). Epigenetic modification occurs by enabling or restricting access to DNA so as to increase or limit expression of proteins from specific segments. Specifically, near the sections of DNA that code for specific proteins are CpG islands, repeated series of cytosine and guanine that molecularly initiate the transcription process. Epigenetic modification occurs when methyl groups attach to this area, preventing transcription (Deaton & Bird, 2011). Global DNA methylation would act as a metric for how much DNA is accessible (Kurdyukov & Bullock, 2016). It will be taken as representing Gottlieb's (2007) genetic stratum of activity.

Interleukin-6 is a cytokine released in response to stressful events to moderate immune system response (Malven, 1993). Research examining epigenetic etiologies of anxiety and depression have identified high rates of interleukin-6 as a possible mechanism (Kahl et al., 2016; Murphy et al., 2015; Yehuda et al., 2015). Relating specifically to happiness, interleukin-6 and good immune system function in general were identified to be associated with happiness (Steptoe, Dockray, & Wardle, 2009). Lastly, interleukin-6 has been identified as an important protein in inducing epigenetic changes (Foran et al., 2010). Interleukin-6 will be taken as representing the neurological stratum of Gottlieb's (2007) theory.

Cortisol has historically been identified as eliciting fight or flight reactions. It acts as a signaler along the hypothalamus-pituitary-adrenal axis that facilitates physiological responses to stressors (Malven, 1993; Padgett & Glaser, 2003). This stress response functionality is theoretically fitting because Winston's (2016) theory places happiness within a context of responding to environmental events. Furthermore, as with interleukin-6, mood has been identified in relation to cortisol through research considering epigenetic etiologies of anxiety and depression, anxious and depressed participants higher in rates of cortisol (Kahl et al., 2016; Yehuda et al., 2015). Specifically related to happiness, cortisol has been identified within Shelley Taylor's positive illusion construct (Taylor, Lerner, Sherman, Sage, & McDowell, 2003). Positive illusions represent bold optimism in face of daunting odds. People who employed positive illusions tended to have lower rates of cortisol. Cortisol will be taken as representing the neurological stratum of Gottlieb's (2007) theory.

These three chemicals will account for the genetic and neurological strata of Gottlieb's (2007) theory. The behavior stratum, and the focus of this analysis, is the experience of subjective happiness. Happiness will be defined along the lines of Winston's (2016) theory using the personal fulfillment inventory that was assessed by Tanzer et al. (manuscript 1). This measure is a 36 item questionnaire with three subscales, one for each form of happiness as defined by Winston (2016). Lastly, the environment stratum of Gottlieb's (2007) theory will be accounted for by the use of the hassles and uplifts scale (Bolt, 2001; DeLongis, Folkman, & Lazarus, 1988). Common life events are provided and ranked on a scale from 1 to 3 regarding how much they were a hassle and how much they were an uplift within the past week. This will provide a partially objective assessment of recent environmental turbulence.

With the epimarker, two biomarkers, scales for happiness, and metric of recent environmental hassles and uplifts, the full range of Gottlieb's (2007) contextual strata may be quantified. It is hypothesized that there will be sizable correlations between all variables, as Gottlieb's (2007) interconnected feedback would imply. Seeing previous correlations between negative affect and cortisol and interleukin-6, it is hypothesized that there will be a specifically negative relationships between these biomarkers and Winston's (2016) happiness, positive affect.

The second aim of this analysis is to consider the credibility of Winston's (2016) theory within Gottlieb's (2007) framework. This will primarily be accomplished by analyzing the relationships with each individual subscale of the personal fulfillment inventory as indicative of experienced pleasure, engagement, and meaning. Furthermore, developmental relationships will also be of interest. Winston's (2016) theory expands on

Seligman's (2002) with explicit foundations in developmental psychology. In evaluating her theory, paying attention to developmental variables will be informative. Two variables will be taken as providing developmental interpretation: years of postsecondary education and global DNA methylation. Years of postsecondary education was selected because it accounts for the experience based driver of personal development Winston (2016) places at the base of her theory. Though age is often viewed as the classic developmental variable, people of different backgrounds may have different frequencies and extremities of life experiences. Years of postsecondary education was considered a more standardized metric of personal development that would be theoretically more relevant to Winston's (2016) theory.

Changes in DNA methylation are strongest during the first years of life (Wang et al., 2012). That said, there is an emerging line of research identifying DNA methylation as a possible etiology for diseases with onset later than early childhood, including cancer (Feinberg & Tycko, 2004; Fukushima et al., 2017; Jones & Laird, 1999; Zhang et al., 2016), Alzheimer's disease (Zawia, Lahiri, & Cardozo-Pelaez, 2009; Zhao et al., 2017), schizophrenia (Whitton et al., 2016), alcoholism (Heilig et al., 2017), depression, and anxiety (Bartlett, Singh, & Hunter, 2017; Dalton, Kolshus, & McLoughlin, 2014). Outside of psychopathology, some have gone so far as to suggest that epigenetic feedback is a normal way in which cells adapt to environmental change (Furusawa & Kaneko, 2013), possibly a fundamental underpinning of basic functions in learning and memory (Gluck, Mercado, & Myers, 2016). Furthermore, an epigenetic physiology could provide physiological credibility to the stage based organization of Winston's (2016) theory, for which there is a long theoretical history in developmental psychology.

Establishing epigenetic links with years of postsecondary education and happiness as defined by Winston (2016) will be informative.

The following hypotheses can be considered. In Winston's (2016) original writing, pleasure is identified as generally preferred by less fulfilled people, engagement as preferred by moderately fulfilled people, and meaning preferred by deeply fulfilled people. The hypothesis follows then that there will be a negative correlation between years postsecondary education and pleasure, a positive correlation with meaning, and minimal correlation with engagement. Lastly, if DNA methylation is taken as the physiological mechanism by which development is driven, then the hypothesis follows that there will be a positive correlation between years postsecondary education and DNA methylation.

Reviewing hypotheses across aims, there are a number of further hypotheses that can be inferred based on the hypothesized relationships. It was hypothesized that there would be negative correlations between happiness and biomarkers cortisol and interleukin-6. Understanding the physiological mechanics of epigenetic modification via methylation, it follows that global DNA methylation will be negatively associated with the biomarkers. It stands to reason then that DNA methylation will have a positive correlation with happiness, mediated by two negative correlations to and from the biomarkers.

There remain some exploratory components to this analysis. The relationships with hassles and uplifts are unclear. Happiness research historically has identified recent negative events as greatly outweighing positive events, implying a negative relationship between hassles and uplifts and happiness. More recently, there has been debate as to the

mathematical foundations of the original work and the conditions under which this effect is identified (Fredrickson, 2013b). The relationships with this variable will be explored.

Lastly, there can be identified a logical inconsistency across hypotheses. It was hypothesized that there would be a positive correlation between DNA methylation and years postsecondary education, which implies a positive correlation between all forms of happiness and years postsecondary education. That said, it was hypothesized from theory that there will be a negative relationship between pleasure and years postsecondary education; a positive relationship between meaning and years postsecondary education; and minimal relationship between engagement and years postsecondary education. Empirically contrasting these two predictions will be important to fully understand the developmental pathways of happiness.

Methods

Procedures

Twenty-four hours before participants joined the study, they were asked to refrain from caffeine, alcohol, or smoking, known covariates of Cortisol (Mehl & Conner, 2012). Additionally, they were provided with a modified version of the brief trauma questionnaire (Schnurr, Vielhauer, Weathers, & Findler, 1999). Participants who had experienced trauma within the past month (e.g., returning from an active combat zone) were to be asked not to participate. No participants failed the screening. Informed consent was acquired in compliance with the University of Rhode Island Institutional Review Board. Surveys were administered using pen and paper. Saliva samples were collected using the passive drool method with saliva collection tubes purchased from Salimetrics (Salimetrics, 2018). Samples were immediately placed in a freezer at -20° C.

Participants

Participants were 20 students at the University of Rhode Island. Specifically, ten of them were undergraduate students (age, $M=20.00$ years, $SD=1.15$ years; 3 male, 7 female; 3 African American, 7 white), and ten of them were graduate students (age, $M=25.78$ years, $SD=0.83$ years; 10 female; 1 Asian, 9 white). Participants were recruited from psychology classes and were compensated with extra credit.

Materials

Saliva Samples

Cortisol was quantified within samples using the Expanded Range High Sensitivity Salivary Cortisol Enzyme Immunoassay Kit purchased from Salimetrics (catalog number 1-3002). Interleukin-6 was quantified within samples using Salivary IL-6 ELISA Kit purchased from Salimetrics (catalog number 1-3602). DNA was prepared using the QIAamp DNA Mini Kit (catalog number 51304). Global DNA methylation was quantified within samples using the MethylFlash Global DNA Methylation (5-mC) ELISA Easy Kit (Colorimetric) purchased from EpigenTek (catalog number P-1030-48). Samples were tested in triplicate. All samples were analyzed for cortisol and interleukin-6; however, only 9 samples were analyzed for DNA methylation. Due to financial limitations, only samples with sufficiently pure DNA could be analyzed for DNA methylation (i.e., $1.50 < 260/280 < 2.15$). Nine samples were analyzed, 3 undergraduate and 6 graduate. To air on the side of conservatism, unconditional mean imputation was used for the remaining samples.

Though multiple imputation is often preferred to unconditional mean imputation, this approach was avoided out of concern that relationships would be inflated within the

canonical correlation analysis. Imputed values were calculated, and the mean of the imputed values was insignificantly different from the mean of observed (observed, $M=0.37\%$, $SD=0.15\%$; imputed, $M=0.42\%$; $SD=0.50\%$; $t(12.02)=-0.34$, $p=0.7433$).

Though insignificance does not necessarily mean that there is no difference, there was a fairly small effect size between the groups (Cohen's $d=0.13$). Seeing minimal evidence of difference between the groups, unconditional mean imputation was preferred so as to not over interpret variance observed in the sample.

Questionnaires

Two questionnaires were used: the personal fulfillment inventory and the hassles and uplifts scale. The personal fulfillment inventory is a composite scale organized by Tanzer et al. (manuscript 1). It is a 36-item scale that drew from five questionnaires (specifically, the five needs satisfaction measure from Taormina & Gao, 2013; the orientations toward happiness scale from Schueller & Seligman, 2010; the fear checklist from Walters, 2000; the ethics position questionnaire from Forsyth, 1980; and the self-control scale from Tangney, Baumeister, & Boone, 2004). Exploratory and confirmatory factor analyses were performed to identify questions that were quantitatively (i.e., coefficient omega >0.80 , significant factor loadings, majority of the variance accounted for) and theoretically compatible with Winston's (2016) description of happiness. There are three subscales, one for pleasure, one for engagement, and one for meaning. Individual items elicited various responses (i.e., binary, which of the following do you fear; continuous, on a scale of 1 to 9 how much do you agree with the following; continuous, on a scale of 1 to 5 how much do you agree with the following). To account for this, responses to items were transformed in a weighted linear combination to

standardize their scores based on proportional importance as theorized by Winston (2016). Scores ranged from 0 (representing no experienced fulfillment) to 4 (representing high experienced fulfillment). For more detail on this, see Tanzeret al. (manuscript 1).

The hassles and uplifts scale used here was a shortened version of a much longer original scale. Though the full scale, created by DeLongis, Folkman, and Lazarus (1988), includes 53 items, the version used in this analysis only used the 10 most frequent hassles and 10 most frequent uplifts for student populations identified by Bolt (2001).

Participants are provided with a list of all items and asked to rate how much each event has been a hassle and how much each event has been an uplift. Events are rated on a scale from 0 (representing none or not applicable to today's experience) to 3 (representing a great deal impactful on today's experience). Items are rated twice, once as a hassle and once as an uplift. An example item is "having fun," which would likely be rated a 0 as a hassle and a 3 as an uplift. Another example is "wasting time," which might be rated a 3 as a hassle and a 2 as an uplift. On individual subscales, there is a possible range from 0 (representing no hassles or uplifts) to 60 (representing many hassles or uplifts). The scale used in this analysis included hassles and uplifts together for a sum total of hassles and uplifts together, with a possible range of score from 0 (representing nothing eventful today) to 120 (representing a very eventful day).

Analytic Strategy

Canonical correlation was used to analyze the data. There were four variables of happiness correlated with four variables for the remaining strata of Gottlieb's (2007) theory. The four happiness variables are as follows: pleasure, engagement, meaning, and years of postsecondary education. Pleasure, engagement, and meaning were grouped

together because they represent each of Winston's (2016) three forms of happiness. Years of postsecondary education was included with them to allow for a direct examination of a possible developmental ordering to Winston's (2016) theory. The four variables of Gottlieb's (2007) remaining strata, hereafter referred to as stress response variables, are as follows: hassles and uplifts, cortisol, interleukin-6, and DNA methylation. These variables were grouped together because they represent the strata of Gottlieb's (2007) theory in relation to the stress response framework which Winston's (2016) theory assumes. This will allow for a specific analysis of how Winston's (2016) theory of happiness acts within Gottlieb's (2007) broader contextual framework.

It should be considered that canonical correlation is not typically used with sample sizes as small as 20. To account for this, an a priori power analysis was performed to assess whether or not sample size will be a limitation. The required population effect size to have at least 80% power with a 5% type 1 error rate was calculated to be $R^2=0.41$. In psychology research, this is often considered a very large effect size, and may be a limitation for the analysis. This issue may be mitigated because lab sciences tend to have larger effect sizes than social sciences. Chemical assays were performed in triplicate to reduce error and more easily identify and remove obvious outliers.

Even if the true population effect size is $R^2=0.26$, the standard definition of large according to Cohen (1992), power was calculated to remain at 0.43. Though this is much lower than would be desired, it is not uncommon for studies within psychology research to have power of this magnitude (Aberson, 2011). Though the effectiveness of this analysis may rely on a large effect size, that is not unrealistic because subscales of

happiness were compiled with careful attention to their relationships to each other, and impure saliva samples were excluded.

Results

Overall Results

Descriptive statistics are displayed in Table 1. Generally speaking, participants experienced moderate amounts of happiness as pleasure or meaning, and lower amounts of happiness as engagement (meaning: $M=2.51$, $SD=0.42$; pleasure: $M=2.36$, $SD=0.35$; engagement: $M=1.87$, $SD=0.34$). Half of participants were graduate students, and half were undergraduate, the mean number of years postsecondary education was 4.65 years ($SD=2.40$ years). Participants generally did not experience too many impactful hassles and uplifts ($M=35.18$ hassles and uplifts, $SD=12.29$ hassles and uplifts). Cortisol counts were relatively small ($M=0.49$ ug/dL, $SD=0.20$ ug/dL); though smaller in absolute volume, interleukin-6 had larger variation within the sample ($M=1.93$ pg/mL, $SD=1.43$ pg/mL). Estimates of overall DNA methylation were quite low ($M=0.37\%$, $SD=0.15\%$).

Distributions were examined for normality (i.e., skewness $<|1.0|$, kurtosis $<|2.0|$). DNA methylation and happiness as engagement were a bit skewed and kurtotic, but not unreasonably so (DNA methylation: skewness = 2.56, kurtosis = 6.97; engagement: skewness = 2.19, kurtosis = 4.99). Additionally, omega was low for the pleasure and meaning subscales of the personal fulfillment inventory (pleasure: omega = 0.63; meaning: omega = 0.56). It is likely this was because the sample was half undergraduate students and half graduate students. Though this is not ideal, it is not expected to have had a great impact on the results. This issue will be examined further in the discussion. The remaining variables were considered appropriate for research samples.

Simple bivariate correlations were first examined between each pair of variables. Correlations between happy variables can be found in Table 2, stress response variables in Table 3, and across sets of variables in Table 4. Correlations were frequently insignificant, however this may be due to the small sample size. Contrary to expectations, years postsecondary education had a positive relationship with pleasure ($r = 0.20$), and a negative relationship with engagement ($r = -0.25$) and meaning ($r = -0.52$). Meaning had a moderate positive relationship with both engagement and pleasure (pleasure: $r = 0.33$; engagement: $r = 0.31$), however there was a small and negative relationship between engagement and pleasure ($r = -0.14$).

Correlations within stress response variables were generally negative and moderate to small. The strongest correlations were between DNA methylation and the biomarkers, strongest for cortisol ($r = -0.57$) but still moderately large a relationship with interleukin-6 ($r = -0.39$). This was in line with the hypothesis. The only positive correlation was between cortisol and interleukin-6 ($r = 0.10$), as was hypothesized. Global DNA methylation had a negative correlation with hassles and uplifts ($r = -0.30$). There was no significant or meaningful relationship between hassles and uplifts and biomarkers (cortisol: $r = -0.07$; interleukin-6: after rounding, $r = 0.00$).

Correlations between the two sets of variables were mixed positive versus negative, though generally nonsignificant. DNA methylation had a negative and large correlation with pleasure and meaning (pleasure: $r = -0.74$; meaning: $r = -0.52$). Though it remained a negative association, the correlation was much smaller between engagement and DNA methylation ($r = -0.04$). Seeing a small sample size, this may not be a meaningful relationship. A similar pattern was observed for cortisol, which had positive

and moderate correlations with pleasure and meaning (pleasure: $r=0.29$; meaning: $r=0.32$) and a very small correlation with engagement ($r=0.07$). Interleukin-6 had negative correlations with all variables of happiness, however the strongest relationships were with engagement ($r=-0.24$) and meaning ($r=-0.13$) and virtually no correlation with pleasure ($r=-0.01$). Happiness as pleasure had a negative and small correlation with hassles and uplifts ($r=-0.10$), a large correlation with meaning ($r=0.49$), and the largest correlation with engagement ($r=0.70$). Older students tended to have fewer hassles and uplifts ($r=-0.40$) and concentrations of interleukin-6 ($r=-0.06$) and larger percentages of DNA methylation ($r=0.39$). There were few differences by years of postsecondary education for rates of cortisol ($r=-0.06$).

Canonical correlation was used to examine in more detail the relationship between variables of happiness as defined by Winston (2016) (i.e., happiness as pleasure, engagement, meaning, and years postsecondary education) and stress response variables (i.e., hassles and uplifts, cortisol, interleukin-6, and global DNA methylation). The results can be found in Tables 5 and 6. Overall, the model was significant (for Wilk's lambda, $F(16, 37.298)=2.75, p=0.0055$) and accounted for the vast majority of the variance ($\eta^2=0.91$). Only the first linear combination was significant (linear combination 1: $F(16, 37.298)=2.75, p=0.0055$). That said, the second linear combination was nearly significant ($F(9, 31.79)=1.92, p=0.0851$) and accounted for a large amount of shared variance across the linear combinations (linear combination 1: 63%; linear combination 2: 32%). One possible reason for its near significance is the small sample size. Briefly reviewing the canonical coefficients (presented in Table 7), it would appear that the first function prioritizes hassles and uplifts while the second linear combination

prioritizes DNA methylation. Seeing near significance, a large proportion of shared variance, and theoretical relevance, the second linear combination will be included in the analysis despite being nonsignificant.

Function 1

Table 7 provides model estimates. Reviewing the estimates for happiness within the first function, this linear combination seems to represent the developmental progression towards deeper conceptions of happiness (i.e., meaning and engagement). These provided the largest canonical coefficients (meaning: standardized loading=0.68; engagement: standardized loading=0.67). Furthermore, the canonical coefficient for pleasure was moderately large and negative (standardized loading=-0.50). Years postsecondary education had a moderate positive canonical coefficient (standardized loading=0.34).

Stress response variables for the first function drew primarily from hassles and uplifts. The largest loading was for hassles and uplifts, a large and positive influence (standardized loading=0.94). Cortisol and DNA methylation did have an influence on the function, however it was moderate (cortisol: standardized loading=0.39; DNA methylation: standardized loading=0.43). Interleukin-6 had a moderately small negative canonical coefficient (standardized loading=-0.29). This function can be interpreted as the relationship between stress and health: experience of recent life events paired with bodily response.

Reviewing the correlations between the canonical function for happiness and the variables of happiness, correlations were strong and directionally similar to as hypothesized. The correlation between the happiness function and pleasure was

moderate and negative ($r=-0.30$) while the relationship between the happiness function and meaning was large and positive ($r=0.54$). Year in college had a moderate and negative relationship with the happy function ($r=-0.28$). Contrary to expectations, the strongest correlation with the happiness function was engagement, resulting in a very large positive correlation ($r=0.86$).

Correlations between the canonical function for stress response and the variables of stress response were mixed. As hypothesized, there was a negative correlation between the stress response function and interleukin-6 ($r=-0.29$) as well as a small, positive correlation between the function and DNA methylation ($r=0.17$). Additionally, there was a positive correlation between hassles and uplifts and the stress response function ($r=0.83$). Contrary to expectations, there was a positive relationship between the stress response function and cortisol, however it was a small relationship ($r=0.11$).

Next, correlations were considered between the stress response function and the variables of happiness. The pattern of correlations was similar to the pattern observed for the happiness function. There were large, positive relationships for meaning and engagement (meaning: $r=0.46$; engagement: $r=0.74$), a small negative relationship for pleasure ($r=-0.28$), and a small negative relationship with years postsecondary education ($r=-0.24$). Likewise, the pattern of correlations between the happiness function and the variables of stress response variables were similar to their correlations with the stress response function. There were positive relationships for hassles and uplifts and DNA methylation (hassles and uplifts: $r=0.71$; interleukin-6: $r=0.15$), a rather small positive relationship with cortisol ($r=0.09$), and a moderate negative relationship with interleukin-6 ($r=-0.31$). These results indicate close relationships across Gottlieb's (2007) strata.

Redundancy analysis indicated the meaningful content of the functions. The ability to predict happiness variables using the stress response function demonstrated strength in predicting meaning and engagement (meaning: $R^2=0.21$; engagement: $R^2=0.55$) with much less ability to predict pleasure or years postsecondary education (pleasure: $R^2=0.07$; years postsecondary education, $R^2=0.06$). The happiness function was more balanced in its predictions, predicting cortisol and hassles and uplifts most of all with much less ability to predict interleukin-6, cortisol, and DNA methylation (hassles and uplifts: $R^2=0.50$; interleukin-6: $R^2=0.09$; cortisol: $R^2=0.01$; DNA methylation: $R^2=0.02$). Development as Winston (2016) defined demonstrated changes in how hassles and uplifts are experienced most of all with some changes in physiology.

This point is further examined by the combined effect sizes of the canonical functions, provided in Table 8. The happy function generally was more effective at predicting both happy variables and stress response variables (happy function predicting happy variables: $R^2=0.30$; happy function predicting stress response variables: $R^2=0.22$). That said, the stress response function did predict a moderate amount of variance. Both functions did similarly well at predicting the opposing variables, accounting for a moderately large amount of the variance for both happy and stress response variables (stress response function predicting stress response variables: $R^2=0.21$; stress response function predicting happy variables: $R^2=0.16$). Altogether, both linear combinations were quite effective at predicting all variables, accounting for nearly three quarters of the variance ($R^2=0.73$).

Function 2

The second happy function analyzed, also presented in Table 7, seemed to represent happiness pleasure. By far, the largest loading was happiness as pleasure, a large and positive addition to the linear combination (standardized loading=1.00). This was counterbalanced by a large and negative canonical coefficient from years postsecondary education (standardized loading=-0.53). Theoretically in line with Winston's (2016) ordering, there was a small and negative canonical coefficient for meaning (standardized loading=-0.10) and a moderately small positive coefficient for engagement (standardized loading=0.24). This function seems to represent low fulfillment high in pleasure and some engagement with diminishing feelings of meaning.

The second stress response function, on the other hand, was dominated by global DNA methylation, specifically whether or not DNA was unmethylated (standardized loading=-0.99). There was a small positive canonical coefficient for hassles and uplifts (standardized loading=0.13). There was virtually no interaction with cortisol (standardized loading=0.01) and contrary to expectations a small negative canonical coefficient for interleukin-6 (standardized loading=-0.18). This function is defined by a lack of DNA methylation, with some influence of interleukin-6 and hassles and uplifts.

Examining correlations between the happiness function and happy variables, there was a close relationship between pleasure and the happy function ($r=0.82$). As hypothesized, there was a moderate relationship between the happy function and engagement ($r=0.33$). An unexpected finding was that there was a large correlation between the happy function and meaning ($r=0.58$). Lastly, as was hypothesized, there was a moderate negative relationship between the happy function and years postsecondary education ($r=-0.34$).

Correlations between the stress response function and stress response variables were more straightforward. There was a large negative relationship between the stress response function and global DNA methylation ($r=-0.98$). As hypothesized, there was a moderate positive relationships between the stress response function and cortisol ($r=0.40$). Though it was directionally as hypothesized, there was a very small positive relationship between the stress response function and interleukin-6 ($r=0.06$), so this may not be a meaningful relationship. There was a moderate positive correlation between the stress response function and hassles and uplifts ($r=0.30$). This provides evidence for DNA methylation as an underlying regulator of physiological stress response.

A similar pattern of results was identified when correlating the stress response function with the happy variables. There were moderately large positive relationships between pleasure and meaning and the stress response function (pleasure: $r=0.63$; meaning: $r=0.44$) with a moderate correlation with engagement ($r=0.15$). There was a moderate negative relationship between years postsecondary education and the stress response function ($r=-0.26$). As with the first function, there was also a similar pattern of results when correlating the happy function with the stress response variables. The strongest relationship was between global DNA methylation and the happy function, a large negative relationship ($r=-0.75$). There were moderate correlations between the happy function and cortisol and hassles and uplifts (cortisol: $r=0.31$; hassles and uplifts: $r=0.23$) with a very small relationship between the happy function and interleukin-6 ($r=0.04$). These confirm the first function's findings of close relationships across Gottlieb's (2007) strata.

The redundancy analyses demonstrated again greater ability to predict happy variables. The stress response function accounted for nearly half of the variance in all of pleasure, engagement, and meaning (pleasure: $R^2=0.47$; engagement: $R^2=0.57$; meaning: $R^2=0.41$). Though less predictive, the stress response function still predicted a moderate amount of variance within years postsecondary education ($R^2=0.13$). The happiness function was very effective at predicting stress DNA methylation and hassles and uplifts (DNA methylation: $R^2=0.56$; hassles and uplifts: $R^2=0.58$). It was less effective at predicting cortisol and interleukin-6 (cortisol: $R^2=0.10$; interleukin-6: $R^2=0.10$).

Finally, the variance explained overall, presented in Table 8, was similarly effective for stress response variables and happiness variables alike. Most effective were functions predicting their own variables (happiness function predicting happiness variables: $R^2=0.29$; stress response function predicting stress response variables: $R^2=0.30$). That said, there was still a moderate amount of variance explained by function predicting opposing variables (happiness function predicting stress response: $R^2=0.17$; stress response function predicting happiness variables: $R^2=0.18$). Lastly, the set of variables overall accounted for the majority of the variance across all eight variables ($R^2=0.59$).

Discussion

Generally speaking, these results provided preliminary evidence for relationships between happiness and a physiology of stress response. Limited by a small sample size, many bivariate correlations were nonsignificant, however the estimated coefficients were often substantial. When accounting for the multivariate environment, the functions demonstrated clear relevance to Winston's (2016) theoretical ordering. Though the

details of how the biomarkers interrelated varied, it was clear that there were relationships across strata of Gottlieb's (2007) framework. There were two aims to this analysis: to assess in detail the physiology of a stress response based view of happiness; and to examine with data a developmental framework to Winston's (2016) theory of happiness. These points will be considered in detail in the following sections.

Physiologies of happiness

The first aim was to assess the physiology of happiness within Gottlieb's (2007) framework. It was hypothesized that there would be negative correlations between measures of happiness (i.e., pleasure, engagement, and meaning) and stress response system functioning (i.e., biomarkers interleukin-6 and cortisol). A check of bivariate correlations was mixed: participants high in interleukin-6 tended to be low in all forms of happiness as hypothesized. Contrary to the hypothesis, participants high in cortisol tended to be also high in all forms of happiness. What will be most informative will be to consider each form of happiness individually. Winston (2016) argued that happiness functions in developmental stages. Though a person may experience any form of happiness moment to moment, it is posited that there are stable preferences that develop over time. Examining physiologies of happiness within context will clarify the relationships between stress response system functioning and happiness in detail.

The first function seemed to represent the presence of mature happiness. As hypothesized, people who were low in interleukin-6 also tended to be high in happiness. That said, contrary to expectations people who tended to be high in cortisol tended to also be high in mature happiness. One possible explanation for this is that the relationship was fairly small, much smaller than the relationship between hassles and uplifts and

mature experiences of happiness. It is possible that the high rates of cortisol are due to high rates of hassles and uplifts more so than experienced happiness. In other words, one possibility is that people who are happier tend to live more turbulent lives. At the same time, people who live more turbulent lives may also tend to have more cortisol because of that turbulence. All in all, this was a correlational analysis, so it is not possible to assess causality, although future researchers may want to examine the role of cortisol in more detail.

The results from the second function were even more counter to the hypothesis. The linear combination seemed to represent the experience of happiness as pleasure. It was hypothesized that people high in happiness would be low on cortisol and interleukin-6. The result was a positive relationship, indicating happy people tended to have higher rates of both cortisol and interleukin-6. Though this was in opposition to the original hypotheses, it should be taken as a confirmation of Winston's (2016) theory. Within her developmental ordering, happiness as pleasure is viewed as the least mature form of happiness. If this linear combination represents the presence of immature happiness, then the hypothesis needs to be revised to expect a positive relationship with cortisol and interleukin-6. In other words, people high in immature happiness would also be high in biomarkers of stress. The second function demonstrated this clearly.

This counterintuitive result may be because of Simpson's paradox. The original hypotheses were not tailored to each definition of happiness within Winston's (2016) theory. The theory is fundamentally stage based. Individually, one can increase happiness for one stage, but there is implied an overall trend from relatively unsatisfied when preferring happiness as pleasure toward relatively deeply satisfied with happiness

as meaning. This was worked into the very measurement of variables: the personal fulfillment inventory provides individual subscales representing fulfillment of each stratified stage. Happiness was measured such that an increase on any subscale would imply an increase in happiness. The true nature of happiness may not be so reductionist. An increase on happiness as pleasure may not be proportionally as relevant as an increase on happiness as meaning. A person high in pleasure will be measured as very happy, but the theory would imply that such a person is not very happy at all. For this reason, a positive relationship between happiness as pleasure and biomarkers of stress was taken as providing some confirmation of the hypothesis and Winston's (2016) theory.

Lastly, there remains the exploratory analysis of hassles and uplifts. Results were consistent: in both functions of happiness, there was a positive relationship with hassles and uplifts. Reviewing the descriptive statistics stratified between hassles and uplifts, participants generally experienced more uplifts than hassles, which may be informative. Historically, research has indicated that recalled hassles tend to outweigh recalled uplifts and negatively affect perceived happiness (Fredrickson, 2013b). That said, these results indicate otherwise. Participants tended to remember more uplifts than hassles, and those who recalled more events in general tended to be happier across functions of happiness.

Furthermore, it is worth noting that there was a closer relationship between hassles and uplifts for mature happiness than for happiness as pleasure. This may be theoretically relevant. In her original theory, Winston (2016) suggests that the deepest levels of happiness, when experienced as meaning, are inherently value neutral. Definitions of good and bad are redefined by their broader meaningful implications. A close relationship between hassles and uplifts and meaning may indicate greater

emotional depth from all experiences. The stress of hassles in particular may have been less likely to reduce happiness as meaning than happiness as pleasure.

Developmental definitions of happiness

There were two developmental variables considered in the analysis: years postsecondary education and global DNA methylation. Years postsecondary education, which will be considered first, was taken as representational of Winston's (2016) experience-based view of happiness. It was hypothesized that years postsecondary education would correlate negatively with pleasure, positively with meaning, and have minimal relation with engagement. It was expected that people with fewer professional experiences (i.e., few years of postsecondary education) would prefer happiness as pleasure; people with more professional experiences (i.e., many years of postsecondary education) would prefer happiness as meaning; and happiness as engagement would be developmentally in the middle. A check of bivariate correlations revealed the reverse of these hypotheses. As students spent more time at universities, they tended to appreciate pleasure more. Likewise, older students tended to appreciate meaning less. Though the progression was reverse what had been expected, the ordering was intact. Engagement did demonstrate a negative correlation, but it was not as strong a relationship as was demonstrated for pleasure or meaning. Examining the multivariate results will be informative for teasing apart this unexpected ordering.

Though the bivariate correlations were opposite what was expected, the linear combinations provided clearer evidence in support of Winston's (2016) theory. The first function seemed to represent increasing depth of happiness, and there was a positive canonical coefficient for years postsecondary education. In other words, when the data

were modeled to maximize relationships among all variables, older students tended to have more mature conceptions of happiness. The same can be said for the second function, which seemed to represent happiness as pleasure. In this case, the canonical coefficient was negative. In other words, students high in pleasure, experiencing immature feelings of happiness, tended to be younger.

Perhaps most informative to why bivariate correlations were so different from the canonical coefficients is to examine the correlations between the happy function and years of postsecondary education: in both cases, the correlations were negative. It may be that older students were less happy in general than younger students. To isolate years of postsecondary education may be to isolate the one aspect of a global loss of happiness that comes with advanced study. The linear combinations seek to maximize relationships within the data across all variables. It is only by accounting for variance across all forms of happiness as defined by Winston (2016) that the trend appears as hypothesized. As before, this may be an effect of measurement. It may be in separating happiness into subscales that the results get complicated, even if the canonical coefficients are clearly as can be hypothesized from Winston (2016).

The other developmental variable was DNA methylation. It was hypothesized that there would be negative relationships between DNA methylation and cortisol and biomarkers (i.e., cortisol and interleukin-6). Within Winston's (2016) developmental framework, it was hypothesized that older students would have higher rates of DNA methylation. A check of bivariate correlations confirms many of these hypotheses. Participants with highly methylated DNA had lower rates of cortisol and interleukin-6 and tended to be older.

Within the multivariate context, results were mixed. In the first function, there was a positive estimate for DNA methylation and a negative estimate for interleukin-6 as hypothesized, but a positive estimate for cortisol. As previously discussed, this may be because of relationships between cortisol and hassles and uplifts. Hassles and uplifts were very influential within the first linear combination and cortisol is sensitive to recent experiences. It is possible this dependency between these variables complicated the relationship with cortisol. The second function also had an unexpected result, this time between DNA methylation and interleukin-6 both estimated negative. This may be due to the double role interleukin-6 plays as inflammation cytokine and molecular facilitator of DNA methylation. There may be true associations between DNA methylation and interleukin-6 that complicate model fitting. Furthermore, the linear combination was largely defined by DNA methylation, which may have pulled out this dependency between these two variables. Lastly, this unexpected result disappeared when interleukin-6 was correlated with the linear combination. Put simply, there seem to be multiple relationships between DNA methylation and interleukin-6 here documented.

The hypothesized relationships between DNA methylation and positive psychological constructs (i.e., pleasure, engagement, meaning) were logically inconsistent, making full hypothesis evaluation uncertain. One possibility was positive relationships between all variables of happiness and DNA methylation, as implied by hypothesized relationships with biomarkers. Alternatively, it could also be hypothesized that there would be a positive relationship with meaning, a negative relationship with pleasure, and minimal relationship with engagement, as implied by hypothesized relationships with years postsecondary education. The observed bivariate correlations

confirmed neither of these expectations: participants who had highly methylated DNA tended to be lower in all forms of happiness. This may be because of the general nature of global DNA methylation. This metric was selected as an overall metric of personal physiological development. What was gained by being general came at a loss to specificity. This variable accounted for genome wide DNA methylation, including many unquantified proteins.

Within the multivariate context, DNA methylation's relationships to the happiness function were closer to hypotheses. Participants with highly methylated DNA tended to experience mature feelings of happiness, demonstrated in the first function as hypothesized. In the second function, participants with highly methylated DNA tended to experience less pleasure. Pleasure being the least mature form of happiness, it is expected that there would be a negative relationship. And these data supported this. Participants who enjoyed pleasure tended to have unmethylated DNA. This provides evidence for the developmentally implied hypotheses of happiness. These results together do provide evidence in support of a physiological view of Winston's (2016) theory. Questions about the mediating pathways from DNA methylation to experienced happiness, though this is likely in part because of the general measure of DNA methylation used.

The relationship between years postsecondary education and DNA methylation within the multivariate analysis were as hypothesized. The first function estimated a positive coefficient for DNA methylation, and there was a positive coefficient for years postsecondary education. Likewise, in the second function, DNA methylation had a negative estimated coefficient, and there was a negative coefficient for years

postsecondary education. Across both functions, DNA methylation was mirrored by years postsecondary education.

Lastly, in the exploratory analysis of the relationships to hassles and uplifts, there was less consistency than was observed in happiness. In both functions, hassles and uplifts had a positive estimate, whereas DNA methylation changed from a positive estimate in the mature happiness function to a large negative estimate in the pleasure function. This may be a difference in objectivity between hassles and uplifts and DNA methylation. Whereas happiness and perceived hassles and uplifts share large psychological characteristics, there is less direct a relationship between DNA methylation and hassles and uplifts. Hassles and uplifts are not entirely psychological, but partially influenced by random events of daily experience. This may have added enough noise to the data to change these relationships that were stronger between DNA methylation and happiness. Furthermore, even within Gottlieb's (2007) theory, genetics and environment have a mediated connection, but are on opposite theoretical extremes. This may be a demonstration of their distance from each other.

Limitations and future directions

What may have been a limitation of this analysis was the low metrics of internal consistency for the personal fulfillment inventory. This is likely because the sample was made of a mix of undergraduate and graduate students. Moreover, it was likely that six specific items on the questionnaire likely were of specific issue: "Moral standards are simply personal rules that indicate how a person should behave, and are not be applied in making judgments of others," "Ethical considerations in interpersonal relations are so complex that individuals should be allowed to formulate their own individual codes,"

“Rigidly codifying an ethical position that prevents certain types of actions could stand in the way of better human relations and adjustment,” on the pleasure subscale; and “Risks to another should never be tolerated, irrespective of how small the risks might be,” “The existence of potential harm to others is always wrong, irrespective of the benefits to be gained,” and, “The dignity and welfare of the people should be the most important concern in any society,” on the meaning subscale.

These items are included on the scale because they represent conceptions of morality, an important aspect of Winston’s (2016) theory. That said, they are the most wordy and complicated questions on the questionnaire. There was one student, an undergraduate, who upon turning in his questionnaire packet said to the researcher that these six questions made no sense to him. It is likely that graduate students and undergraduate students responded to these questions differently, resulting in low metrics of internal consistency for the pleasure and meaning subscales. The personal fulfillment inventory was normed on a sample of undergraduate students (Tanzer et al., manuscript 1), and though it originally showed appropriate internal consistency among undergraduate students, the mixed sample may have resulted in the low values.

That said, though internal consistency was a limitation, it was not seen as the largest threat to validity. In the original study where the personal fulfillment inventory was compiled, these complicated questions added little meaningful variance to the scale overall (i.e., low and nonsignificant factor loadings for the majority of the questions, see manuscript 1). The items were included in the analysis for theoretical value, but it was not expected that they would be statistically influential. Though it would have been

preferred to have better observed internal consistency, the low values were not seen as the largest limitation to the results.

What was a larger limitation to this study was the sample size. For a canonical correlation analysis, 20 participants is generally viewed as quite small (Harlow, 2014). Moreover, due to differences in DNA preparation quality, not all of the samples could have been tested. Imputing simple averages for missing data was taken as a step to be conservative, however future research would benefit from a larger sample with complete data. Furthermore, though not unreasonably so, DNA methylation was fairly skewed and kurtotic. Furthermore, the second linear combinations were dominated by happiness as pleasure and DNA methylation, suggesting there may have been multicollinearity. Replication of results would be valuable.

Another direction especially if future researchers have a larger sample would be a mediational design. The size of the sample was so small that a mediational analysis was not considered an analytic option, however the research question was mediational in conceptualization. The full hypothesized path was from DNA methylation, to interleukin-6, to cortisol, to happiness, to hassles and uplifts, the whole span of Gottlieb's (2007) strata. This correlational approach identified a relationship between methylation and happiness, but in theory this direct effect would be subsumed by a mediated effect. With a larger sample, a longitudinal mediation analysis would be informative as to whether or not methylation alone has an effect on happiness, or if it is as hypothesized only correlated because of the physiological mechanics facilitating the relationship. Alternatively, repeated measures could be used to investigate the temporal ordering of

these relationships. A cross lagged panel design could investigate the assumed but untested causality underlying these results.

Being able to assess causality and mediation within these mechanics is important because there were many covariates that were not included in the analysis. First of all, participants were all highly educated, and correlated therewith likely of a higher socioeconomic status. Though there appears to be minimal effect of socioeconomic status on happiness (Lyubomirsky, 2007), it is a well-documented limitation within the field of psychology that marginalized populations are understudied (Matsumoto & Van de Vijver, 2010). Outside of dependencies relating to socioeconomic status, students are generally quite young. Winston's (2016) theory emphasized a lifelong developmental process transitioning existential experiences of happiness. Future researchers should consider sampling more demographically diverse populations, especially so far as it relates to socioeconomic status and age.

Future research could also examine different biomarkers. Cortisol and interleukin-6 were selected because they are directly related to stress response system functioning and a primary goal of this analysis was to place happiness in a stress response framework. That said, there are other neuropeptides that interact with stress response system functioning that may seem more intuitive choices for studying happiness. One such neuropeptide is oxytocin. Oxytocin historically has been identified as facilitating maternal functions, such as the release of milk during lactation and uterine contractions (Rosenzweig, Breedlove, & Leiman, 1996). In recent years, oxytocin has been the subject of study among positive psychologists for its relationship to calming and social bonding. It is so popular in the study of gentleness and tenderness that it is sometimes

given the moniker “cuddle hormone” (Fredrickson, 2013c; Neff, 2011; Sapolsky, 2017). Another alternative neuropeptide of possible interest for future researchers is beta endorphin. Beta endorphin is an endogenous opioid that acts as a pain reliever (Rosenzweig, Breedlove, & Leiman, 1996), it has also been suggested as facilitating a sense of greater life purpose (Ishida 2012). Examining the relationships between these neuropeptides, and others, will be informative to understanding the physiology of happiness in greater detail.

Beyond expanding biomarkers considered, another possible direction would be to examine different epimarkers. Global DNA methylation was selected because the goal of this analysis was exploratory, and global DNA methylation is a general metric of overall epigenetic modification. That said, much more detail could be provided into the underlying epigenetic mechanics. For example, specific methylation on CpG islands near the binding sites of biomarkers would be strong evidence for epigenetic modulation of the expression of happiness. Further yet, this study did not sequence DNA itself. Future researchers should consider the most complete theoretical path, including genetic sequence, epigenetic modification, protein production, and finally expression of happiness.

Conclusion

The fundamental goal of this analysis was to identify a personal physiology that may mechanically facilitate happiness as a subjective phenomenon. Seeing close relationships between happiness and health, the question was posed as to whether or not happiness exists within a broader frame of psychological and physiological functioning. It was hypothesized that global DNA methylation would interact with the expression of

biomarkers for stress response, which in turn would interact with experienced happiness. On the most basic level the results were clear. People with highly methylated DNA tended to have lower rates of biomarkers of stress, and higher reports of subjective happiness. Though more can be done to examine the pathways between stress response and happiness, this analysis provided initial evidence in favor of happiness existing within a stress response theoretical framework.

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Table 1.
Descriptive statistics

Variable	Mean	SD	Min	Max	Skew	Kurt	Omega
<u>Happiness</u>							
Pleasure	2.36	0.35	1.60	3.10	-0.12	0.38	0.63
Engagement	1.87	0.34	1.53	2.93	2.19	4.99	0.90
Meaning	2.51	0.42	1.60	3.18	-0.26	-0.31	0.56
Years postsecondary education	4.65	2.40	1.00	8.00	0.14	-1.53	
<u>Stress response</u>							
Hassles and uplifts	35.18	12.29	13.00	69.00	0.67	1.97	0.88
Cortisol (ug/dL)	0.49	0.20	0.20	0.81	-0.05	-1.34	
Interleukin-6 (pg/mL)	1.93	1.43	0.00	5.55	0.73	0.61	
Global DNA methylation (%)	0.37	0.15	0.27	0.74	2.56	6.97	

Table 2.
Correlations within variables of happiness

	Pleasure	Engagement	Meaning	Years postsecondary education
Pleasure	1.00			
Engagement (<i>r, p</i>)	-0.14 0.5549	1.00		
Meaning (<i>r, p</i>)	0.33 0.1563	0.31 0.1907	1.00	
Years postsecondary education (<i>r, p</i>)	0.20 0.3954	-0.25 0.2875	-0.52 0.0187	1.00

Table 3.
Correlations within stress response variables

	Daily hassles	Cortisol	Interleukin-6	Global DNA methylation
Daily hassles (<i>r, p</i>)	1.00			
Cortisol (<i>r, p</i>)	-0.07 0.7534	1.00		
Interleukin-6 (<i>r, p</i>)	-0.00 0.9953	0.10 0.6709	1.00	
Global DNA methylation (<i>r, p</i>)	-0.30 0.4343	-0.57 0.1097	-0.34 0.3709	1.00

Table 4.*Correlations between variables of happiness and stress response*

	Pleasure (<i>r, p</i>)	Engagement (<i>r, p</i>)	Meaning (<i>r, p</i>)	Years postsecondary education (<i>r, p</i>)
Daily hassles (<i>r, p</i>)	-0.10 0.6787	0.70 0.0007	0.49 0.0287	-0.40 0.0777
Cortisol (<i>r, p</i>)	0.29 0.2196	0.07 0.7817	0.32 0.1735	-0.06 0.7921
Interleukin-6 (<i>r, p</i>)	-0.01 0.9612	-0.24 0.3024	-0.13 0.5956	-0.19 0.4226
Global DNA methylation (<i>r, p</i>)	-0.74 0.0220	-0.04 0.9222	-0.52 0.1495	0.39 0.2980

Table 5.*Overall canonical correlation results*

	Lambda	F	Numerator df	Denominator df	<i>P</i>	Eta ²
Wilks' Lambda	0.092	2.75	16	37.298	0.0055	0.907

Table 6.
Linear combination results

Linear combination	Adj Canon Corr	SE	Eigenvalue	Shared variance	Shared cumulative variance	F	Num df	Denom df	p
1	0.795	0.061	2.7545	0.632	0.632	2.75	16	37.298	0.0055
2	0.743	0.095	1.415	0.325	0.957	1.92	9	31.789	0.0851
3	0.269	0.197	0.1646	0.038	0.995	0.64	4	28	0.6402
4	0	0.224	0.0222	0.005	1.000	0.33	1	15	0.5727

Table 7.*Standardized coefficients, correlations, and individual redundancy analysis*

		<u>Function 1</u>				<u>Function 2</u>		
Variable	Coefficient	<i>rh</i>	<i>rs</i>	Redundancy analysis	Coefficient	<i>rh</i>	<i>rs</i>	Redundancy analysis
Happiness								
Pleasure	-0.50	-0.30	-0.26	0.07	1.00	0.83	0.63	0.47
Engagement	0.67	0.86	0.74	0.55	0.24	0.20	0.15	0.57
Meaning	0.68	0.54	0.46	0.21	-0.10	0.58	0.44	0.41
Years postsecondary education								
	0.34	-0.28	-0.24	0.06	-0.53	-0.34	-0.26	0.13
Stress response								
Daily hassles	0.94	0.83	0.71	0.50	0.13	0.30	0.23	0.56
Cortisol	0.39	0.11	0.09	0.01	0.01	0.40	0.31	0.10
Interleukin-6	-0.29	-0.36	-0.31	0.09	-0.18	0.06	0.04	0.10
Global DNA methylation	0.43	0.17	0.15	0.02	-0.99	-0.98	-0.75	0.58

Note: rh represents correlations with the happiness function and and rs represents correlation with the stress response function

Table 8.
Overall redundancy analysis

Function	<u>Function 1</u>		<u>Function 2</u>	
	Happy variables	Stress response variables	Happy variables	Stress response variables
Happy canonical function	0.3019	0.2215	0.2941	0.1723
Stress response canonical function	0.1574	0.2146	0.1769	0.3019
R^2	0.7337		0.5859	