TURUN YLIOPISTO

Heritability of Life Satisfaction

Syventävien opintojen kirjallinen työ
Turun Yliopisto
Lääketieteen koulutusohjelma
Lääketieteellinen tiedekunta
Kansanterveystieteiden kliininen laitos

Laatija:
Annika Suontama

10.1.2025
Espoo

Syventävä opinnäyte

Oppiaine: Kansanterveystiede
Tekijä: Annika Suontama
Otsikko: Heritability of Life Satisfaction
Ohjaajat: LT Säde Stenlund ja dosentti Sakari Suominen
Sivumäärä: 46 sivua
Päivämäärä: 10.1.2025

Abstract

In recent decades, life satisfaction has gained attention as a dimension of positive mental health. It refers to a cognitive and subjective evaluation of one's life as a whole. Accumulating evidence suggests that life satisfaction is associated with favourable physical and mental health outcomes. This makes life satisfaction a highly relevant topic of research as the quest for new solutions for the burdened health care systems continues. Previous research has reported a profound heritable aspect to it. This integrative scoping review aims to examine and summarise findings on the heritability of life satisfaction.

The literature search was conducted through the Pubmed database and snowball search methods broadened the body of publications. First, studies providing numerical heritability estimates are presented, followed by additional literature grouped to identify factors influencing these estimates.

The findings from predominantly twin studies show that the variation in life satisfaction is significantly influenced by genetic factors. The heritability estimates are mainly in the range of 30-40%. In addition to genetic influences, research underlines the importance of unique environmental influences and gene-environment interactions. Life satisfaction and its heritability has been shown to vary in different groups and environments, thus implying that altering environmental conditions could enhance life satisfaction.

The remarkable heritable component in life satisfaction opens an opportunity for developing targeted interventions and policies in the future. On the other hand, the significance of unique environments also leaves a promising space for interventions. Understanding the mechanisms through which genetic and environmental factors influence life satisfaction remains a key direction for future research.

Key terms: life satisfaction, twin study, heritability, genetics, subjective well-being

Table of Contents

1. Introduction

1.1 General Introduction to Life Satisfaction

As the prevalence of mental health challenges continues to rise, focus is being placed on the positive dimensions of mental health for its possible buffering effect against these challenges. Life satisfaction represents a dimension of positive mental health. It comprises a subjective and cognitive evaluation of one's quality of life, based on one's own set of criteria (Diener, 1984; D. N. Miller, 2011). An evaluation of life satisfaction considers life as a whole rather than a person's momentary levels of happiness (Veenhoven, 1996). Accumulating evidence suggests that in addition to the associations between life satisfaction and mental health (Lombardo et al., 2018; Michalski et al., 2022), life satisfaction is also closely linked to better physical health outcomes (Diener et al., 2017; Diener & Chan, 2011; Koivumaa-Honkanen et al., 2000; Ngamaba et al., 2017). This connection underlines the value of studying life satisfaction for public health as the increase in chronic conditions challenges the sustainability of health care systems.

Life Satisfaction (LS) is often viewed as a construct of a broader concept, subjective well-being (SWB) (Diener, 1984). SWB includes people's appraisals and evaluations of their own lives and is divided in two components. LS is the cognitive evaluation of one's life. Conversely, the affective component of SWB includes both positive and negative affect representing the emotional aspects of well-being. In both dimensions, the evaluation is subjective. LS is often perceived as a general evaluation compared to the momentary and spontaneous feeling of happiness (Kahneman & Riis, 2005). Therefore, LS is a reflection of perceptions and expectations of the surrounding environmental circumstances rather than those circumstances themselves (Hahn et al., 2013). In addition, LS represents an overall judgement of life as a whole and should therefore be differentiated from satisfaction with certain life-domains, such as satisfaction with one's marriage (Ehrhardt et al., 2000).

It is argued that the cognitive and affective components are distinct and should be considered separately though many overlaps occur (Badri et al., 2022; Kahneman, 2010, 2010; Luhmann et al., 2012; Shin & Johnson, 1978). However, many sub concepts of SWB such as life satisfaction

or happiness are regrettably frequently used interchangeably in the literature (Layard, 2010). For clarity and accuracy, this literature review mainly focuses on studies specifically concerning life satisfaction.

The study of LS has grown rapidly along with an increased interest in positive psychology. In contrast to traditional psychology, which often centres around treating mental illness and dysfunction, positive psychology focuses on the positive aspects of human experience and behaviour, emphasising factors that contribute to a fulfilling and meaningful life (Gable & Haidt, 2005; M. Seligman & Csikszentmihalyi, 2000). Researchers in positive psychology explore topics such as happiness, optimism, life satisfaction, gratitude, resilience and strengths with the goal to cultivate aspects of life that lead to human flourishing (Gable & Haidt, 2005). This transition in the field of mental health toward positive indicators has even been referred to as a "paradigm adjustment" (Maddux, 2008; M. E. P. Seligman & Csikszentmihalyi, 2014). Even intergovernmental organisations, such as the World Health Organization (WHO) and Global Happiness Council have recommended that countries should consider positive well-being and use its indicators when making policy decisions (WHO 2020; The Global Happiness Council, 2022)

The factors influencing LS range from genes to health and societal conditions (Badri et al., 2022; Bartels, 2015; De Neve et al., 2012; Ngamaba et al., 2017). LS has shown to be moderately heritable, with heritability estimates from twin and family studies usually between 30 to 40% (Bartels, 2015; Stubbe et al., 2005). This indicates that genetic differences account for a remarkable effect on LS scores. Heritability has been explained largely as a result of differences in personality (Anglim et al., 2020; Hahn et al., 2013; Røysamb et al., 2018). Even though it is well-established that LS is heritable, our understanding is limited about the biological mechanisms by which the genes operate. While genes play a significant role in LS, the impact of environmental factors is even more substantial. Hence, LS is malleable and can indeed change, making its study highly meaningful and relevant.

1.2 Outcomes of Life Satisfaction

During the past decades the research on LS and SWB has grown considerably. Studies have shown LS to be linked to overall well-being, and its positive impact extends both to physical and mental health. Numerous studies have consistently shown that higher levels of LS promote health and longevity (Diener et al., 2017; Diener & Chan, 2011; E. S. Kim et al., 2021; Koivumaa-Honkanen et al., 2000; Ngamaba et al., 2017; Saunders et al., 2018; Strine et al., 2008; Xu & Roberts, 2010). For example, a recent longitudinal study conducted by Kim and colleagues (2021) found that individuals reporting higher LS exhibit improved health behaviours, a reduced risk of mortality, and a lower incidence of chronic pain and diseases, among other positive outcomes (E. S. Kim et al., 2021). Life dissatisfaction, on the other hand, has also shown to be a predictor of mortality and serve as a general health risk indicator (Koivumaa-Honkanen et al., 2000, 2001, 2004; Zullig et al., 2001).

In addition to its impact on physical health, LS has continuously shown associations with positive mental health and favourable psychological outcomes (Koivumaa-Honkanen et al., 2011; Lombardo et al., 2018; Michalski et al., 2022). LS is negatively correlated with poor mental health both in adults and in adolescents (Fergusson et al., 2015; Haworth et al., 2017; Michalski et al., 2022; Strine et al., 2008; Zullig et al., 2005). The link between depression and reduced LS is especially well-supported by numerous studies (Haworth et al., 2017; E. S. Kim et al., 2021; Koivumaa-Honkanen et al., 2004, 2011; R. B. Nes et al., 2013; Strine et al., 2008). Furthermore, LS is also associated with social well-being, for example demonstrated as reduced loneliness (E. S. Kim et al., 2021). All these findings emphasise the value of LS for psychosocial functioning. It is nevertheless important to keep in mind that many of the studies are cross-sectional, which makes it challenging to assess causality. It is likely that several of these associations are also bidirectional, implying that improved health may also enhance an individual's LS, not just the other way around (Stenlund, Junttila, et al., 2021).

The findings on the outcomes and correlates of LS point to its crucial role in the social and economic realms. Higher LS is associated with a higher likelihood of marriage and childbirth, and with lower rates of divorce, unemployment and crime, all of which are desirable for the society and the well-being of individuals (Grant et al., 2009; Luhmann et al., 2012; Olson et al., 2021). The effects of LS can extend to the workplace, as satisfied individuals are often more productive, creative and satisfied with their job (Acar et al., 2021; Bryson et al., 2017; DiMaria et al., 2020; Oswald et al., 2015; Tan et al., 2021). On an economic scale, nations with higher levels of LS tend to have more stable societies (Bottoni & Addeo, 2024; Helliwell, 2003; Helliwell et al., 2014). Given these major positive impacts on both the individual and societal level, LS is gaining emphasis in public health and societal development.

The study of LS has broad implications that extend to various domains, contributing to the development of policies and interventions aimed at enhancing both individual and societal well-being. Understanding the factors that contribute to LS could help individuals to adopt healthy lifestyle choices and behaviours (Stenlund, Koivumaa-Honkanen, et al., 2021). Furthermore, such beneficial choices could positively impact their overall well-being (Stenlund, Junttila, et al., 2021). Research can also provide information to guide public health promotion and health care planning, for example, by emphasising the value of mental health promotion, and illness prevention. Supporting citizens' SWB could potentially reduce health care costs through improved health. Moreover, an understanding of LS can guide policies regarding economy, education and work. As LS, and subjective well-being, appear to have many beneficial effects, placing well-being at the centre of policies has been argued to be urgent to allow everyone in the society to flourish (De Neve et al., 2013).

2. Methods

This integrative scoping literature review had two primary aims: 1) to examine and summarise findings on the heritability of LS and 2) to outline the determinants relevant to heritability and environment that underlie LS. To address these aims, a literature search was primarily conducted through the Pubmed database. The initial search included key terms such as “life satisfaction”, “satisfaction with life”, “heritability”, “genetics” and “twin studies” combined using Boolean operators. The search was limited to articles published in English and after 2000, yielding in 118 search results.

A snowball search was also conducted by manually reviewing the reference lists of relevant articles, which added several publications to the review. To be included in the review, the articles had to report a specific measure of life satisfaction and have a sample size of over 100 participants. Ultimately, 23 articles were found to fill the requirements and address the research questions. In addition, numerous publications were referenced to elaborate on the main findings. The reviewed materials include research articles, meta-analyses and review articles.

The majority of the studies included had been published after 2000. However, some articles discussing the theory behind LS date back to the two preceding decades. The review emphasises studies with larger sample sizes albeit smaller studies are also considered in the absence of larger ones. The original plan was to focus on prospective parent-child association studies but the lack of research in these studies led twin studies to be the main source for heritability estimates. To get a more comprehensive picture of the heritability of LS, the twin studies were complemented by some family- and genetic studies. LS was the concept of primary interest. However, insufficient information has been supplemented by exploring studies under the broader umbrella of SWB, including studies of happiness or SWB as a whole.

The review first presents the background of studying LS followed by the main findings regarding its heritability. All the studies providing a numerical estimate of heritability are presented in a table found in chapter 3.3.1 (see Table 1). The review continues by discussing these estimates and examining the multiple factors affecting LS.

3. Results

3.1 Study of Life Satisfaction

3.1.1 Measuring Life Satisfaction

LS is measured through self-report scales, which capture personal evaluations and experiences. Although several different kinds of scales are used, the common goal is to measure a conscious cognitive judgement of one's life as a whole in which the criteria for judgement are up to the person (Diener, 1993). The scales mostly vary in regard to the formulation of questions or the number of individual items.

The most known scale is The Satisfaction With Life Scale (SWLS) by Diener (Diener, 1984). It is applied in many studies in the field of studying LS (Caprara et al., 2009; De Neve et al., 2013; Pelt et al., 2023; Røysamb et al., 2002; Stubbe et al., 2005). The 5-item scale is intended to measure overall cognitive evaluations of one's LS. Participants rate their level of agreement with each of the 5 statements on a 7-point scale, where 7 represents "strongly agree" and 1 represents "strongly disagree". Examples of the items are the following: "I am satisfied with my life" and "If I could live my life over, I would change almost nothing". The scale was developed to assess satisfaction with the respondent's life as a whole and not to assess satisfaction with specific life domains. Therefore, it allows the subjects to weigh these domains in whatever way they choose (Diener, 1993).

Another commonly used measure is a single-item question referred to as the Cantril Ladder (Helliwell et al., 2023). First, it asks the respondents imagine a ladder with the best possible life for them being a 10 and the worst possible life being a 0. Then, each respondent evaluates their current life on that 0 to 10 scale. This measure is used, for example, in the well-known World Happiness Report as a measure of happiness.

The large variety in measuring well-being, different questionnaires and scales, sometimes causes difficulties in comparison of the results. There is also some concern regarding the reliability of the scales. A review about LS scales by Diener suggests that factors such as question order, current mood, and presentation format may influence LS scales, although these variables can typically be controlled for (Diener et al., 2013). The sensitivity of the questions to the context in which they are asked is still unclear, research showing inconsistent results (Deaton & Stone, 2016; Schimmack & Oishi, 2005). Furthermore, some studies suggest that different scales may produce different results (Gatt et al., 2014; Jamshidi et al., 2020).

Even though concerns exist, there is evidence that the scales are surprisingly valid (Cheung & Lucas, 2014; López-Ortega et al., 2016). For example, the weather or mood effects are found not to affect the judgments of LS significantly (Lucas & Lawless, 2013; Yap et al., 2017). Further, according to Diener and colleagues (2018) and despite the subjective nature of the scales, self-reporting has shown to be reliable (Diener et al., 2018). It has been consistent with evaluation from others and objective measures of subjective well-being.

3.1.2 Twin studies

In the study of the heritability of LS, the vast majority of studies are based on quantitative genetics and employ the classical twin design (CTD). Twin studies compare the phenotypes of monozygotic twins, who have identical genetic material, with dizygotic twins and singleton siblings, who share approximately 50% of their genes. This allows the estimation of the relative importance of genetic and environmental influences. Twin studies do not identify specific genomic regions responsible for variation in LS and well-being (R. B. Nes & Røysamb, 2016). In the CTD, the quantitative genetic and environmental influences are divided in four parameters: additively (A) and non-additively (D) acting genes, and shared (C) and nonshared (E) environments. The parameters are derived mathematically based on the differences between the correlations of mono- and dizygotic twins (R. B. Nes, Røysamb, et al., 2010; Wootton et al., 2017).

Additive genetic effects (A) refer to the combined influence of numerous individual alleles that contribute additively to the phenotype. These effects represent the total summative contribution of multiple genes. Non-additive genetic effects (D), on the other hand, result from interaction between alleles, either within the same locus (dominance) or across different loci (epistasis). In such cases, the expression of a genetic variant depends on the presence of other genetic variants. Shared (or common) environmental factors (C) pertain to the environments that affect both twins in the same way, thus contributing to twin similarity. Non-shared environmental factors (E) are environments that affect the twins differently, making them less similar. (R. B. Nes, 2009; Røysamb et al., 2003; Wootton et al., 2017)

LS is known to have a significant heritable component (Bartels, 2015). If a person inherits multiple alleles associated with positive traits, they are likely to have a higher innate predisposition for LS due to the additive effects of these genes. However, the eventual LS cannot be derived straightforwardly from these genetic effects, because the genes interact and might modify each other's expression. Some genes may have a stronger impact when they occur together, or one gene might dominate the effect of another. These are referred to as non-additive genetic effects. Furthermore, growing up in a family where supportive relationships and a generally optimistic outlook are shared, could contribute to shared environmental factors. Nonetheless, even identical twins sharing the same genes and living in the same family may have differences in their LS due to non-shared environmental factors. For example, one of the twins might have different hobbies compared to the other one, have distinct personal experiences, or is being treated somewhat differently influencing her or his LS.

Non-additive genetic influences and the effect of shared environmental are confounded in the classical twin (sibling) design and CTD studies do not thereby permit the simultaneous exploration of them. Thus, the two parameters are estimated in separate models (Bartels & Boomsma, 2009; R. B. Nes, Røysamb, et al., 2010). Moreover, the twin model does not take into account the possibility of gene-environment interplay (GxE) directly (R. B. Nes & Røysamb, 2016). GE interplay refers to both correlations and interactions between genes and environment. Broadly, this phenomenon means that individuals with specific genotypes for a trait are more

likely to encounter certain environments, or that the effect of a particular environmental factor may vary depending on an individual's genotype for that trait (Sauce & Matzel, 2018). The proportions of genetic and environmental effects can consequently be distorted.

In the study of heritability, the term heritability encompasses both additive and non-additive genetic effects and describes the proportion of total variance attributable to genetic factors. Broad sense heritability (H^2) refers to the contributions from both additive and non-additive genetic effects, whereas narrow-sense heritability (h^2) implies only to the additive influences. (R. B. Nes & Røysamb, 2016)

3.2 Determinants of Life Satisfaction

In general, people are relatively satisfied with their lives. A large meta-analysis and an independent study report an average LS of 28.7 and 27.8 (range 5-35) when measured with the Satisfaction With Life Scale (SWLS) (Anglim et al., 2020; Stubbe et al., 2005). When examining comprehensively the whole world, the mean satisfaction is lower. The World Happiness Report (e.g. Helliwell et al., 2019) offers annual rankings of life evaluations in countries worldwide, measured using the Cantril Ladder. On a scale from 0 to 10, the global mean score is 5.45, varying from 1.9 in Afghanistan to 7.8 in Finland. Typically, the Northern European countries reach the highest scores, while countries with war, instability and poverty, such as those in sub-Saharan Africa, score the lowest (Helliwell et al., 2023; Ortiz-Ospina & Roser, 2023). For example, the average LS in 37 OECD countries, mostly developed western nations, was 6.7 (OECD, 2020). Overall, there is great variation in LS between different countries.

LS is found to be fairly stable (Anusic & Schimmack, 2016; Diener, 1993; Ehrhardt et al., 2000; Fujita & Diener, 2005; Hudson et al., 2017; Koivumaa-Honkanen et al., 2005; Paunio et al., 2009; Strine et al., 2008). In contrast, there is generally more fluctuation within the two other components of SWB, positive and negative affect. Although LS shows stability, it can also change permanently and significantly over long periods of time (Anusic & Schimmack, 2016;

Hudson et al., 2017; Lysberg et al., 2021). Research indicates that there are genetic effects contributing to the stability of LS (Lykken & Tellegen, 1996; R. Nes et al., 2006; R. B. Nes et al., 2013). LS is, in other ways as well, highly dependable on genetic factors. Several studies indicate that genetics play an important role in explaining individual differences in LS (e.g. Bartels, 2015; Bartels & Boomsma, 2009; Hahn et al., 2013; Hufer-Thamm & Riemann, 2021; Pelt et al., 2023; Røysamb et al., 2018; Stubbe et al., 2005). In individual studies, the estimates of heritability vary, but meta-analyses provide relatively consistent results and demonstrate that genes are a significant determinant of LS.

The contribution of genes to LS appears to be due to intrapersonal factors, most importantly personality (Anglim et al., 2020; DeNeve & Cooper, 1998; Hahn et al., 2013; Keller et al., 2005; Weiss et al., 2008, 2016). Studies agree on the fact that there are two characteristics especially relevant to LS. Literature shows that more extroverted and less neurotic people are more satisfied with their lives (Fowler et al., 2018; Hufer-Thamm & Riemann, 2021; Luhmann & Eid, 2009; Røysamb et al., 2018; Steel et al., 2008; Weiss et al., 2008). Self-esteem is also an important correlate of LS (Caprara et al., 2009; Diener et al., 1999; Joshanloo, 2024). A review by Røysamb and Nes (2018) reports personality in whole to account for 32 % of the variation in LS (Røysamb et al., 2018). Moreover, Hahn (2013) argued that genetic influences on LS were completely shared with personality (Hahn et al., 2013). It appears that LS and many personality facets are largely influenced by the same set of genes (Hahn et al., 2013; Weiss et al., 2008). In addition to personality, some other psychological propensities also share genetic influences with LS. One well-established example is the shared aetiology of lower LS and depression (e.g. Nes et al., 2008, 2013).

The rest of LS is attributable to numerous different factors, constituting a relatively studied topic. While many factors from personality and environment to genes have been found to contribute to LS, certain studies have also consistently revealed that many of the demographic variables (i.e ethnicity, gender, education) only have a minor effect on the variation in LS (Ash & Huebner, 2001; Diener et al., 1999; Lykken & Tellegen, 1996). In regards to gender, several studies report the difference between males and females to be from zero to statistically insignificant (Bartels & Boomsma, 2009; Caprara et al., 2009; R. B. Nes et al., 2008, 2013; Røysamb et al., 2002; Stubbe

et al., 2005). However, some studies have found statistically significant sex-differences (Grant et al., 2009; Haworth et al., 2017). For example, a study conducted with 9,463 participants found that men scored higher on LS (Haworth et al., 2017). Other studies finding a gender-difference typically report males being slightly more satisfied with their lives than females. Exceptions to this pattern have also been observed (e.g. Becchetti & Conzo, 2022; Helliwell et al., 2023).

The relationship between LS and age is also somewhat regular. Studies usually show that LS decreases with age (Bartels & Boomsma, 2009; Deaton, 2008; Luhmann & Eid, 2009; Ren et al., 2022). Another typical finding is a U-shape in LS by age (Graham & Ruiz Pozuelo, 2017; Helliwell et al., 2023). One study using data of 500,000 randomly sampled Americans and West Europeans documented a U-shape in LS by age in 72 developed and developing nations (Blanchflower & Oswald, 2008). The U-shape finding has recently also faced some critique and opposite evidence in a study with 298,547 participants from 69 countries (Bartram, 2021). The study concluded that although they could not find a U-shape as such, age does nevertheless affect people's LS.

Socioeconomic status, education and household income are found to explain a part of the variation in LS (Adedeji et al., 2021; Ash & Huebner, 2001; Bishop et al., 2006; De Neve et al., 2012; Deaton, 2008; Jebb et al., 2018; Johnson & Krueger, 2006; Proto & Rustichini, 2013; Ren et al., 2022). The correlation is positive, meaning that a higher socioeconomic status, education and income correlate with more satisfaction with life, although potentially only up to a certain point. Jebb and colleagues (2018) found that LS reached a plateau at an annual income of US$ 95,000 (Jebb et al., 2018). Killingsworth and colleagues (2021), however, found no evidence of an income threshold like this (Killingsworth, 2021). Furthermore, studies report that financial satisfaction is a stronger correlate of LS in poorer countries compared to the wealthier ones (Diener & Diener, 1995; Oishi et al., 1999; Proto & Rustichini, 2013). Interestingly, income seems to be a relatively strong predictor of LS but a less reliable measure when it comes to predicting positive and negative feelings, or in other words, the emotional part of happiness (Diener et al., 2010; Kahneman, 2010).

Religion is among the well-established predictors of LS (Desmond et al., 2018; Lim & Putnam, 2010; H. K. Y. Ng et al., 2024; Ngamaba & Soni, 2018; Sander, 2017; Schellekens & Okun, 2024; Zotti et al., 2016). Religious people consistently report higher levels of LS and better psychological well-being. This may be partly explained by factors such as a sense of meaning in life and social relations and community. The positive effect of religion on LS has been captured across different religions, such as Christianity, Islam and Buddhism.

Health-related and cultural factors are also associated with LS. Numerous studies show that healthier individuals are more satisfied with their lives (Badri et al., 2022; Bishop et al., 2006; De Neve et al., 2012; Grant et al., 2009; Koivumaa-Honkanen et al., 2000, 2011; Ngamaba et al., 2017; Oh & Bae, 2023). Furthermore, studies indicate that self-related health correlates more with LS than objective measures of health (Ng et al., 2017). This fits with the definition of LS—a lot of it comes from an individual's own perceptions and attitude. Regarding cultural factors, divergence between different cultures and geographical areas occur, as noted previously (De Neve et al., 2012; Deaton, 2008; Graham & Ruiz Pozuelo, 2017; Grant et al., 2009; Helliwell et al., 2023; Konkolÿ Thege et al., 2017). These differences are at least partly explained by societal issues such as corruption, social equity and social trust (Helliwell, 2006; Ren et al., 2022; Tay et al., 2014). As a result, Nordic countries with strong security systems rank highest in global comparisons of citizen's LS (Helliwell et al., 2023).

Overall, environmental effects seem to be the strongest predictor of LS (Bartels, 2015). Fulfilling basic needs has an important role in this (Tay & Diener, 2011). Environments change and therefore levels of LS also tend to change in response to significant life events such as unemployment or reemployment, divorce, bereavement, childbirth, retirement, and migration (Anusic & Schimmack, 2016; Bühler et al., 2023; Fujita & Diener, 2005; Lucas, 2007; Lucas et al., 2003; Luhmann et al., 2012; Luhmann & Eid, 2009; Wootton et al., 2017). These events can possibly have long-lasting or even permanent effects on LS, although adaptation is also common (Luhmann et al., 2012).

Social support and good relationships are a salient predictor for LS (Amati et al., 2018; Bishop et al., 2006; De Neve et al., 2012; Helliwell & Putnam, 2004; Koivumaa-Honkanen et al., 2011;

Pelt et al., 2023; Wang et al., 2017). One notable link appears to be between marital status and LS. Studies have repeatedly shown that married people are significantly more satisfied with their lives than unmarried (Graham & Ruiz Pozuelo, 2017; Kahneman, 2010; Koivumaa-Honkanen et al., 2011; Malvaso & Kang, 2022; R. B. Nes, 2009; Ren et al., 2022; Whisman et al., 2014). However, after the wedding, LS soon adapts back to baseline levels, and the boost in LS after getting married typically lasts only for a few years (Lucas et al., 2003). This would indicate that the people who get married have a higher LS already in the first place.

In sum, the studies on LS show that it is an outcome of several factors. Most of the studies linking LS to certain factors identify correlations, not causality, so the relationship can move in both directions or a third factor could affect both variables. Due to the complexity of the construct, it has also been hard to discover the direct mechanisms by which the different variables function and are related to each other. Future research is therefore needed.

3.3 Heritability of Life Satisfaction -Findings

3.3.1 General Estimates

There is solid evidence for a genetic base for LS. Numerous twin and family studies from several different countries typically report the heritability estimation to range 20% to 60% (Bartels, 2015; Bartels & Boomsma, 2009; Caprara et al., 2009; Franz et al., 2012; Stubbe et al., 2005). In these studies, heritability represents the proportion of phenotypic variance accounted for by genotypic variance. Typically, the estimations set between 30% and 40% (Bartels, 2015; R. B. Nes et al., 2008; Røysamb et al., 2018, 2023; Stubbe et al., 2005). For example, a meta-analysis reviewing 10 independent studies reported the weighted average heritability for LS to be 32 % (95 % CI: 29-35) (n = 47,750) (Bartels, 2015). Accordingly, one recent independent study (2023) with 11,216 participants from the Netherlands found a heritability of 35-39% (CI: 31-38; 35-43) depending on the model used (Pelt et al., 2023).

Some medium-sized independent studies have replicated these results with decent accuracy. One highly cited twin-sibling study (n = 5,668) from the Netherlands found a broad sense heritability of 38% (CI: 20-44) for LS (Stubbe et al., 2005). Bartels and Boomsma (2009) reported the exact same estimation of 38% (CI:17-50) (n = 5,024) (Bartels & Boomsma, 2009). Furthermore, Wootton and colleagues (2017) found a slightly higher heritability of 46% (CI: 0.38-0.54) with a British sample (n= 10,915) (Wootton et al., 2017). Finally, Nes and colleagues (2013) had two different samples from Norway (n1 = 2222, n2 = 3298) leading to the estimates of 32% and 41% (Nes et al., 2013). There are several other smaller studies that can be found to correspond to these results (De Neve et al., 2013; Gatt et al., 2014; Hahn et al., 2013; Jamshidi et al., 2020; Røysamb et al., 2018).

There have also been large studies combining measures of LS along with other well-being indicators. One meta-analysis examined both SWB and LS across 13 independent studies, including data from more than 30,000 twins from seven different countries (Nes & Røysamb, 2015). The weighted average heritability was estimated to be 40% (95% CI: 37-42). In addition, a very recent study combined information from national well-being studies and behavioural-genetic studies, both which included investigations into LS, and across 157 counties (Røysamb et al., 2023). A worldwide heritability of 31% to 32% for SWB was found. Accordingly, while there is variability in the estimates found in the literature, studies with larger sample sizes consistently show similar results. Research suggests that the heritability of SWB alone might be slightly higher compared to that of LS (Bartels, 2015; Røysamb & Nes, 2018).

Currently, the highest reported estimation for total heritability of LS is 67 % (Konkolÿ Thege et al., 2017). This study had 272 participants from Hungary with a mean age of 43 years. Another remarkably high estimation was found in a study by Caprara and colleagues (2009) where the broad sense heritability was 59 % (Caprara et al., 2009). This study sample consisted of 854 Italian twins aged 23-24 years. Especially in the former, but also in the latter study, the rather limited sample size could be an underlying reason for the fairly high estimations. In the study by Caprara and colleagues, the authors had, however, assessed the sample to be representative of the general population when comparing the results mathematically with analogous studies. Further,

Wang and colleagues (2017) reported that they found a 60% heritability for LS, even with a slightly larger sample size of 1,215 participants from the UK (Wang et al., 2017). The participants were relatively young at 18 years old, especially when compared to other similar studies.

In contrast, the lowest reported estimation for LS was 19 % with a sample of 1,226 American male twins (Franz et al., 2012)]. LS was measured using a single item which has unknown reliability. The authors state that this may affect the estimation. Another study limitation is the homogeneity of the sample which included only middle-aged men from the United States. Consequently, the findings may not generalise as well to women, other age groups or different cultures.

It is worth mentioning that one study by Harris and colleagues (1992) found actually no evidence for genetic influences on LS in late adulthood in a Swedish sample (mean age 51; n = 1,448) (Harris et al., 1992). All variance in LS was due to nonshared environmental factors. However, the same study reported that in the elderly (mean age 72) the heritability was a substantial 48%. The reason for this exceptional finding is unclear. All in all, the highest and lowest estimations for the genetic base in LS represent the extremes of the range and overall, the estimations are consistent.

Table 1 Overview of heritability studies into life satisfaction

Author	Year	Country	Age	Sample size	Measure	Heritability	95% CI	Study type	Additional effect of shared enviornment	95% CI	Notes
Harris et al.	1992	Sweden	25-75	1448	13-item LS scale	Q1 = 0 Q2 = 48*		Twin study			*Separete estimates for younger and older than 65 years
Stubbe et al.	2005	Netherlands	14-88	5,668	SWLS	38	20-44	Extended twin study			
Johnson & Krueger	2006	United States	25-74	1,438	3-item LS scale	24	0-48	Twin study			
Nes et al.	2008	Norway	18-31	M = 2,687 F = 3,639*	Single-item LS scale	M = 35 F = 18*	M = 26-42 F = 04-31*	Twin study	F = 11		*Separate estimates for males and females
Bartels & Boomsma	2009	Netherlands	13-28	5,024	SWLS	47*		Extended twin study			*9% (0-13) additive, 38% (07-66) non-additive
Caprara et al.	2009	Italy	23-34	856	SWLS	59		Twin study	8	1-20	
Keyes et al.	2010	United States	25-74	1,386	6-item emotional well-being scale*	50**		Twin study	24		*The emotional well-being mesure included measures of life satisfaction, **41% (34-49) additive
Franz et al.	2012	United States	51-60	1,226		19	07-28	Twin study	2	0-13	
DeNeve et al.	2013	United States	18-26	872	Single-item LS scale	33	24-41 *	Twin study			*SE = 0.044
Hahn et al.	2013	Germany	17-	2,616	5-item LS scale	30 (twins) 37 (non-twins)		Extended twin study	0 twins) 32 (non-twins)		
Nes et al.	2013	Norway	Q1 = 18-25 Q2 = 18-31*	Q1 = 2,222 Q2 = 3,298*	Single-item LS scale	Q1 = 41 Q2 = 32*		Twins study	2		*The study was based on two waves of questionnaire data
Whisman et al.	2013	United States	27-74	906	Single-item LS scale	M = 24-25 F = 46-50*		Twin study	M = 11-24 F = 04		*Separate estimates for males and females; two different models for both samples
Gatt et al.	2014	Australia	18-61	1,669	SWLS	31	23-38	Twin study			
Bartels	2015	North America, Europe	14-74	47,750		32	29-35	Twin-family meta-analysis			
Konkoly Thege et al.	2015	Hungary	mean age 43	272	SWLS	67	56-77	Twin study	0		
Haworth et al.	2017	England	16	9,463	6-item LS scale	44		Twin study	12		
Wootton et al.	2017	England, Wales	18-68	10,915	A composite LS scale*	46	38-54	Twin study	10	4-16	*A composite of the multidimensional student life satisfaction scale and the brief multidimensional student life satisfaction scale
Wang et al.	2017	United Kingdom	18	2430	6-item LS scale	60	54-65	Twin study			
Roysamb et al.	2018	Norway	50-65	1,516	SWLS	31	22-40	Twins study			
Jamshidi et al.	2020	Australia	18-62	1,660	SWLS	31	23-39	Twin study			
Hufer-Thamm & Rienabb	2021	Germany	16-25	9,460	SWLS	28		Extended twin study	7 (twins) 13 (non-twins)		
Pelt et al.	2023	Netherlands	17-97	11,305	SWLS	35-39*	31-38, 35-43*	Twin study			*Depending on the level of social support
Roysamb et al.	2023	157 countries		over 200,000	SWB, LS, happiness*	31	30-32	Twin-family meta-analysis	20	16-23	*Several different scales, some of wich included LS

3.3.2 Additive and Non-additive Genetic Effects

Meanwhile the broad sense heritability estimates of LS are fairly consistent, the reported ratio of additive and non-additive genetic effects varies considerably between different studies. Some studies have reported only or mostly additive genetic influences (Gatt et al., 2014; Jamshidi et al., 2020; R. B. Nes et al., 2008; Weiss et al., 2008), whereas others have reported both additive and non-additive genetic effects (Bartels, 2015; Hahn et al., 2013; R. B. Nes, Røysamb, et al., 2010). Moreover, a group of studies show only non-additive genetic effects (Bartels & Boomsma, 2009; Stubbe et al., 2005). With SWB, the results regarding additive and non-additive genetic influences are similarly mixed. Some studies report only additive genetic effects (R. Nes et al., 2006; Røysamb et al., 2002, 2003), while others, including notably large studies, have also found non-additive genetic effects (Lykken & Tellegen, 1996; Nes, Czajkowski, et al., 2010; Nes, Røysamb, et al., 2010; R. B. Nes & Røysamb, 2015; Stubbe et al., 2005).

To display the variance in the results, a study by Stubbe and colleagues (2005) reported a heritability estimation of 32% with only non-additive genetic effects (Stubbe et al., 2005). Another very similar study found, likewise, that 38% of the variance in LS was due to non-additive genetic influences (Bartels & Boomsma, 2009). In both studies, the additive genetic influences were not measurement specific. On the contrary, Hahn and colleagues (2013) found a broad sense heritability of 30-37 % of which 14-17 % was due to additive genetic influences (Hahn et al., 2013). Notably, all three studies were extended twin studies, including other family members in addition to the twin pairs. This enables the accurate distinguishing of the additive and nonadditive components in broad sense heritability (Posthuma & Boomsma, 2000). Additionally, a meta-analysis by Bartels and colleagues (2015) reported both additive and non-additive genetic effects (Bartels, 2015).

On the other hand, there are studies showing only additive genetic effects. Jamshidi and colleagues (2020) found a 31% heritability of LS caused by additive genetic influences (Jamshidi et al., 2020). Gatt and colleagues (2014) had previously reported very similar results (Gatt et al., 2014). However, the latter two studies did not include other family members than twins and the sample sizes were rather small. In some studies, the sample size is stated to be insufficient to

accurately discriminate between additive and nonadditive genetic effects, leading researchers to forgo such analyses altogether (e.g. Caprara et al., 2009; Franz et al., 2012; Keyes et al., 2010; Pelt et al., 2023). Classical twin models are often not enough powerful to distinguish between additive and non-additive genetic effects and thus provide reliable estimates of mainly broad sense heritability (total genetic effect) (Bartels & Boomsma, 2009; Neale & Maes, 2004; Nes et al., 2008).

3.3.3 Sex Differences

Most studies control for factors such as sex and age. Even so, there is evidence from several studies showing that the heritability estimates for LS could be different between males and females (R. B. Nes, Czajkowski, et al., 2010; R. B. Nes et al., 2008; R. B. Nes, Røysamb, et al., 2010; Whisman et al., 2014). One study with 6,326 Norwegian twins got significantly different heritability estimates for males and females (R. B. Nes et al., 2008). The male heritability estimate for LS was 35 % (95% CI: 26-42), while the corresponding female heritability estimation was 18 % (95% CI: 04-43). On the contrary, another study from the United States found the magnitude of genetic effects to be smaller in males compared to females (Whisman et al., 2014). The heritability of LS for men was reported to be 24-25 % and for women 39-50 %. The reason for the almost opposite results compared to previous studies is not addressed in the article. However, the sample size was small, 906 participants, and the measure of LS was based on a single item, which could explain a part of the results.

The findings are equally mixed when studying SWB or its other measurable components. Previous research has indicated that both the extent of genetic effects and the specific set of genes influencing SWB, vary between the sexes (R. Nes et al., 2006; Røysamb et al., 2002, 2003). For example, a study with 8,045 participants reported the broad-sense heritability of SWB (scale including a LS component) to be 36 % (95% CI: 23-44%) in males and 33 % (95% CI: 27-41) in females (Nes, Czajkowski, et al., 2010). Though the broad-sense heritability estimation for SWB was fairly similar across the sexes, the narrow-sense (additive) estimates clearly differed (males 17 %, females 27 %). Røysamb and colleagues (2002), in contrast, found that

genes explained more of the variance in SWB in women than in men (n = 5,864) (Røysamb et al., 2002). In addition, Bartels (2010) studied the heritability of happiness, reflecting the emotional component of SWB with 12,279 subjects and reported the additive genetic effect in males to be 22% (95% CI: 16-28) and in females 41% (95% CI: 37-45) (Bartels et al., 2010). This is in line with the findings by Røysamb and colleagues (2002) described above (Røysamb et al., 2002); the additive genetic component appears to be greater in females than males.

As opposed to certain individual studies indicating a sex-difference in the heritability of LS, several studies and a meta-analysis have failed to show significant differences between males and females (Bartels & Boomsma, 2009; Keyes et al., 2010; R. B. Nes et al., 2013; Røysamb et al., 2018; Stubbe et al., 2005). For example, a study involving 1,516 twins found no evidence of sex differences in heritability (Røysamb et al., 2018). Similarly, Nes (2013) reported LS heritability estimates from two separate samples (n = 2,222, LS 41%; n = 3,298, LS 32%) without finding any sex differences (R. B. Nes et al., 2013). The meta-analysis by Bartels was based on the combination of male and female data, thus not making sex-specific estimation possible (Bartels, 2015). The inconsistency in findings regarding sex differences remains unclear and may stem from variations in study design, sample sizes, cultural contexts, or analytical methods. Further research is needed to explore this subject more thoroughly.

3.3.4 Other Factors Affecting Heritability Estimates

The magnitude of heritability estimates has been shown to vary not only across sex, but also with other personal characteristics such as marital status (R. B. Nes, Czajkowski, et al., 2010; Whisman et al., 2014), social support (Pelt et al., 2023), age (Harris et al., 1992; Stubbe et al., 2005) and socioeconomic status (Johnson & Krueger, 2006). This indicates that certain contexts provide opportunities for varied expressions of heritable propensities. A greater heritability of LS has been indicated for single individuals as opposed to those who are married (R. B. Nes, Røysamb, et al., 2010; Whisman et al., 2014). In one study (n = 906), LS and marital adjustment were significantly associated particularly in females and that the association was also largely influenced by genetic factors (Whisman et al., 2014). This is consistent with the results from

another twin-study (n = 4,462) (R. B. Nes, Røysamb, et al., 2010). The study measured SWB and LS as a part of it. The findings showed that marriage influences the strength of genetic effects on SWB in both males and females. The heritability for SWB was lower among married respondents compared to those who were single. With females, the heritability estimates were 39% (95% CI: 0.29-0.48) for the married and 54% (95% CI: 0.46-61) for the unmarried individuals. The corresponding estimates for males were 41% and 51%.

One explanation for this variance in the heritability of LS is in the social context of marriage. Social support and higher LS are positively correlated (Siedlecki et al., 2014; Wang et al., 2017). In a study by Wang and colleagues (2017), genetic influences were found to explain 68% of the phenotypic correlation (r=0.65) between perceived quality of social support and LS (Wang et al., 2017). In support of this, a study involving 11,305 twins found that genes influencing social support partly overlapped with well-being (Pelt et al., 2023). Moreover, heritability estimates for LS were lower at higher levels of social support. The estimation was 35%–39% depending on the level of social support. These findings would indicate that the role of genes in LS is smaller when an individual has a supportive social network, with marriage being one aspect of it.

The effect of age on the variance of heritability in LS has not been systematically studied. Some studies have, however, reported findings about the subject. There are studies that indicate that age affects the heritability of LS (Harris et al., 1992; Stubbe et al., 2005). In a large study by Stubbe and colleagues (2005) the contribution of genetic factors in satisfaction with life was 38% but in the oldest twin group, with the average age of 72 years, genetic effects on LS were substantially larger at 52 % (Stubbe et al., 2005). Likewise, Harris and colleagues (1992) reported the heritability to be higher in elderly (Harris et al., 1992). Some studies display opposing results. One study with a large sample size (n = 5,024) found no effect of age in the genetic architecture of LS (Bartels & Boomsma, 2009). This was the case also in a meta-analysis by Bartels and colleagues (2015), although the study by Harris and colleagues (1992) was mentioned as an exception to this (Bartels, 2015). Furthermore, Bartels and colleagues (2010) found that the genetic influences on happiness are similar in younger (aged 14–19 years) and older (aged 20–88 years) age groups (Bartels et al., 2010). This is in line with the findings of Nes

and colleagues (2010) when studying SWB and LS as one of its measures (R. B. Nes, Czajkowski, et al., 2010).

There are indications that socioeconomic status and household income are linked with the heritability of LS. A study with 719 twin pairs demonstrated that the heritability of LS was greater among the more privileged and lower among those from less affluent backgrounds (Johnson & Krueger, 2006). Overall, the heritability estimates for LS vary somewhat depending on several different factors. Although many studies consider the effect of these factors on LS as a secondary focus, their influence on the variance components has so far been insufficiently studied. Moreover, when connections have been found, the causal pathways leading to the results have yet remained mainly unclear or unstudied. This opens up a need for more research in the future.

3.3.5 The Heritability of Dispositional Life Satisfaction

In addition to examining the overall heritability of LS as such, some studies have focused on its stable component, thus viewing LS as a persistent trait (Lykken & Tellegen, 1996; Nes et al., 2013; Paunio et al., 2009). This approach is based on the idea that LS (and SWB more broadly) has an individual-specific setpoint, resulting in only moderate fluctuations over time. (Diener et al., 1999; Lykken & Tellegen, 1996). The heritability of this stable component is often found to be remarkably high. For example, a large study estimated the heritability of dispositional (stable) LS at 72% (Nes et al., 2013). Similarly, two studies on SWB, measuring also LS, independently found that up to 80% of long-term levels of SWB are attributable to genetic factors (Lykken & Tellegen, 1996; R. Nes et al., 2006).

Longitudinal studies have found LS to be relatively stable (Fujita & Diener, 2005; Koivumaa-Honkanen et al., 2000, 2005; R. B. Nes et al., 2008; Paunio et al., 2009). Moreover, studies have linked well-being factors, such as LS, closely with stable personality traits, likely due to common genes (DeNeve & Cooper, 1998; Hahn et al., 2013, 2013; Keller et al., 2005; Weiss et al., 2008, 2016). This has provided an explanation for the genetic base in the stability of LS (R. B. Nes,

2009). The stability of the stable characteristics leads to a similar stability in the corresponding indicators that partially emanate from them. There is evidence pointing towards the set point theory, but this view has also been challenged (Headey & Muffels, 2018; Lucas, 2007; Lysberg et al., 2021). First, a review by Lucas (2007) takes a critical viewpoint and demonstrates that the levels of one's SWB do change, adaptation is not inevitable and that life events do matter(Lucas, 2007). Later, with evidence from 20 and 25-year longitudinal studies, Lysberg and colleagues (2021) as well as Headey and Muffels (2018), further criticised the theory, showing that long term within-person LS change is not uncommon (Headey & Muffels, 2018; Lysberg et al., 2021).

3.4 Explaining the Heritability of Life Satisfaction

3.4.1 Personality, Life Satisfaction and Genes

As it has turned out, personality is closely linked with LS. The correlation between personality traits and LS is well-established, supported by a substantial amount of research in this field (Anglim et al., 2020; Busseri & Erb, 2022; Caprara et al., 2009; DeNeve & Cooper, 1998; Fowler et al., 2018; Hahn et al., 2013; Hufer-Thamm & Riemann, 2021; Luhmann & Eid, 2009; Malvaso & Kang, 2022; Mõttus et al., 2024; Oh & Bae, 2023; Røysamb et al., 2018; Schimmack et al., 2004; Steel et al., 2008; Weiss et al., 2008, 2016). Personality refers to a relatively stable and characteristic collection of behavioural, cognitive and emotional patterns that comprise a person's unique adjustment to life (*APA Dictionary of Psychology*, 2018). Studies show that a remarkable amount of individual differences in personality are due to genetic influences (Hopwood et al., 2011; Vukasović & Bratko, 2015; Zwir et al., 2020). Namely, a meta-analysis conducted with over 100,000 participants from several countries reported that the average effect of genetic contributions to differences in personality is 40% (Vukasović & Bratko, 2015). The heritability of personality, along with its connection to LS, has led to the idea of a shared genetic origin between them.

One of the most widely known models to study personality traits is the five factor model (FFM), usually known as the Big Five, which divides personality traits into five basic dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness to experience. Consistent findings from numerous studies indicate that among these five personality traits, neuroticism has the strongest correlation with LS (Anglim et al., 2020; Busseri & Erb, 2022; Hahn et al., 2013; Luhmann & Eid, 2009; Røysamb et al., 2018; Weiss et al., 2016). After low neuroticism, high extraversion is the second strongest personality predictor of LS (Anglim et al., 2020; Hahn et al., 2013; Røysamb et al., 2018). In a meta-analysis with a sample size of over 300,000 subjects, neuroticism correlated -0.39 and extroversion 0.32 with LS (Anglim et al., 2020). However, in a study involving 1,280 Korean elderly individuals no association between extraversion and LS was found. This observation might suggest potential cultural variations (Oh & Bae, 2023). Some studies have found conscientiousness to predict LS as well (Anglim et al., 2020; Busseri & Erb, 2022; Schimmack et al., 2004). According to most of the research, agreeableness and especially openness seem to play a limited role in LS (e.g. Anglim et al., 2020; Busseri & Erb, 2022; Røysamb et al., 2018; Steel et al., 2008).

In addition to the five broad factors of personality, some studies have examined narrower personality facets such as sociability, optimism and pessimism, self-esteem, perfectionism and assertiveness, with several correlations found (Anglim et al., 2020; Caprara et al., 2009; Fowler et al., 2018; Hufer-Thamm & Riemann, 2021; Plomin et al., 1992; Røysamb et al., 2018; Schimmack et al., 2004). The findings seem to support the notion of a “happy personality” (Busseri & Erb, 2022; DeNeve & Cooper, 1998). Overall, personality facets are estimated to explain about 15-33% of the variance in LS (Busseri & Erb, 2022; Malvaso & Kang, 2022; Røysamb et al., 2018; Steel et al., 2008). LS appears to be largely influenced by the same set of genes as neuroticism, extraversion and personality in general (Hahn et al., 2013; Okbay et al., 2016; Røysamb et al., 2018; Weiss et al., 2008, 2016).

First, Weiss and colleagues (2008), with a sample of 973 twin pairs, reported that LS (and SWB) was influenced by unique genetic influences from Neuroticism, Extraversion and Conscientiousness, as well as by a common genetic factor influencing all five personality domains towards low Neuroticism and high Extraversion, Openness, Agreeableness and

Conscientiousness (Weiss et al., 2008). The entire heritability of well-being, measured as perceived LS and control over life, was due to genetic factors in personality and no unique genetic effects of well-being were found. The finding was in accordance with a later study by Hahn and colleagues (2013) who found that genetic influences of LS were completely shared with personality (Hahn et al., 2013). However, Røysamb and colleagues (2018) reported that genetic factors influence LS also beyond the effects of personality (Røysamb et al., 2018). The heritability of LS was 31% (95% CI: 0.22-0.40) of which 65% was explained by genetic effects related to personality.

Both personality and LS are relatively stable across the life span (Bleidorn et al., 2021, 2022; Bühler et al., 2023; Fujita & Diener, 2005; Olaru et al., 2023). Considering that personality is one strong predictor of LS, its stability is likely to cause similar stability in LS. In this light, also the set-point theory of LS seems reasonable (Diener et al., 1999). At the same time, studies show that life events can affect LS also permanently (Bühler et al., 2023; Fujita & Diener, 2005; Headey & Muffels, 2018; Lucas, 2007; Luhmann et al., 2012; Luhmann & Eid, 2009; Lysberg et al., 2021). Personality, though mostly stable, is also malleable and can be changed as a result of major life events (Bleidorn et al., 2021; Bühler et al., 2023). Finally, gene-environment interaction is an important potential factor explaining the correlation between personality and LS. For example, people interact with their environment in a way that is compatible with their personality which, in turn, is partly genetically predisposed (Bartels & Boomsma, 2009; Sauce & Matzel, 2018; Wang et al., 2017). Favourable environments can further affect their LS. This would seem plausible with the trait of extroversion, for instance. Extroversion may lead to stronger social relationships and therefore enhance LS.

3.4.2 Environments

Whereas genes account for about 30 to 40% of the variation in LS (Bartels, 2015; Røysamb et al., 2023; Stubbe et al., 2005), the remaining variation is attributed to environmental influences. In twin studies the quantitative estimates are divided into four genetic and environmental parameters. The environmental influence consists of the shared (common) environment (C) and

nonshared (unique) environment (E) components. Shared environmental factors affect both twins in the same way making them more similar, meanwhile non-shared environmental factors are environments that affect the twins differently, making them less similar (Wootton et al., 2017). As the classical twin design does not allow to explore all the four parameters concurrently, some studies have decided not to differentiate between the C and E, thereby only giving an estimation of all the environmental influences in general or just the E component (e.g. Bartels & Boomsma, 2009; Hufer-Thamm & Riemann, 2021; Nes, Czajkowski, et al., 2010; Stubbe et al., 2005).

Environmental factors make up the primary source of variation in LS, accounting for about 60 to 70%. Traditionally, it is thought that the variation tends to be attributed to nonshared, rather than shared environmental influences, both with LS (Diener et al., 1999; Harris et al., 1992; Jamshidi et al., 2020; Keyes et al., 2010; R. B. Nes et al., 2013; R. B. Nes & Røysamb, 2016; Stubbe et al., 2005) and SWB (Lykken & Tellegen, 1996; Nes, 2015; R. Nes et al., 2006; Røysamb et al., 2002). In a 2009 review, Nes suggests that behaviour genetic findings indicate that familial resemblance is primarily attributable to shared genes rather than shared environments (Nes, 2009). However, numerous studies, some very recent, have found evidence for shared environmental influences (Caprara et al., 2009; Franz et al., 2012; Hahn et al., 2013; Haworth et al., 2017; Hufer-Thamm & Riemann, 2021; Johnson & Krueger, 2006; R. B. Nes et al., 2008; Røysamb et al., 2023; Whisman et al., 2014; Wootton et al., 2017). The same applies for SWB (R. B. Nes, Czajkowski, et al., 2010; Røysamb et al., 2003, 2023). Taking these findings into account, it seems likely that shared environment factors have an effect to at least some extent.

In a study with well-being data from 10,915 individuals, the heritability of LS was reported at 46% (95% CI: 0.38-0.54) and the magnitude of shared environmental effects was 10% (95% CI: 0.04-0.16) (Wootton et al., 2017). This study demonstrates some significant shared environmental influences. Furthermore, some studies have reported that shared environmental influences have a stronger effect on life satisfaction in non-twin family members compared to twins. The earlier study (2013) found a shared environment effect of 6% for twins and 32% on non-twins (n = 2,616) (Hahn et al., 2013). The more recent one (2021) had estimates of 7% and 13% for twins and non-twins, respectively (n = 4,084) (Hufer-Thamm & Riemann, 2021). On the other hand, there is also evidence for the opposite. In a large study on subjective well-being, Nes

and colleagues (2010) examined different types of shared environmental influences, with data from nuclear families (n = 54,540) and twins (n = 6,620). No evidence of environmental transmission from parents to off-spring was found, but 8 % of the total environmental variation was explained by shared twin environments.

The absence of shared environment effects found in some studies would imply that environmental factors common to twins or siblings, such as parenting styles, family socioeconomic status, neighbourhood, and local culture, have only limited impact on well-being (Nes, 2015; Røysamb et al., 2023). However, this appears to be true only on a family-by-family basis (R. B. Nes & Røysamb, 2016). It is suggested that shared environmental factors operate on an individual-by-individual basis. As an example, poverty affects siblings individually and in unique ways and thus is considered as a non-shared environmental factor (R. B. Nes, 2009). In other words, environmental factors that are shared, such as social relationships or cultural influences, can still have non-shared effects if family members perceive them differently. Hence, a particular circumstance can generate both shared and non-shared environmental influences (Hahn et al., 2013).

It is common to observe no significant effects from shared environmental factors in quantitative genetic studies with happiness-related constructs (R. B. Nes & Røysamb, 2016). For example, two large meta-analyses reported that the environmental influences of SWB and LS appear to be non-shared (Bartels, 2015; R. B. Nes & Røysamb, 2015). One of these explored separately LS and SWB (Bartels, 2015), while the other combined these two (R. B. Nes & Røysamb, 2015). However, in a recent study (2023) Røysamb and colleagues argue that the absence of shared environmental influences in these meta-analyses is due to the too homogenous study samples where the heterogeneity of life conditions cannot be effectively captured (Røysamb et al., 2023). Combining data from national well-being studies, the authors report that shared environments account for 16% to 23% of the global variance in subjective well-being when studying the entire global population at a national level in contrast to previous within-country studies. This shared environmental effect would not be limited to within families, as often understood, but rather operate on a national level.

Taken together, although there is evidence for shared environmental effects for the heritability of LS, the non-shared environmental effects play a major role in it. One of the recent World Happiness Reports (2022) using European ancestry samples generalises that about 40% of the variation in happiness can be explained by genetic differences and the remaining 60% is due to environmental factors unique to each individual (Bartels, 2022). Environments, as also genes, operate through several different and partly unknown mechanisms. These include, for example, social support and the effect of significant life events (Franz et al., 2012; Lucas, 2007; Pelt et al., 2023; Warmerdam et al., 2022; Whisman et al., 2014). Moreover, the studies point towards gene-environment interplay where the two components work together resulting in the final level of LS. In this case, genetic factors may modulate exposure to different environments or influence the sensitivity to different environments (Purcell, 2002). In the classical twin design, which is used in most of the studies of LS, it is assumed that genetic and environmental influences are independent of each other. However, these two correlate and interact which can therefore bias parameter estimates in standard twin models (Bartels, 2022; Purcell, 2002; Røysamb et al., 2023). This should be taken into account when interpreting the results.

3.4.3 Gene-Environment Interplay

As already noted in the previous chapter, genes and environment do not work separately but rather in deep interaction with each other. This is referred to as gene-environment interplay (Anreiter et al., 2018). The occurrence of GE interplay with the heritability of LS can be derived from the fact that the heritability estimates have been shown to vary, for example, across sex (R. B. Nes et al., 2008), age (Stubbe et al., 2005), socioeconomic status (Johnson & Krueger, 2006) and marital status (Whisman et al., 2014). These findings imply that environmental factors do indeed influence heritability, and furthermore, that genetic traits can guide individuals toward specific environments.

Gene-environment interplay covers both correlations as well as interactions between genes and the environment. Gene-environment interaction (GxE) describes the phenomenon when the genetic predisposition of an individual controls his or her sensitivity to different environments,

thus meaning that environments affect individuals differently depending on their genotype (Bartels, 2022; Purcell, 2002). A recent twin study investigating the genetic architecture of environmental sensitivity found that genetic influences accounted for 47% (95% CI: 0.30-0.53) (n = 2,868) of the variation in sensitivity (Assary et al., 2021). This supports the idea of sensitivity as a heritable trait. Interestingly, it was also found that sensitivity correlated moderately with neuroticism and extraversion, which are the very same personality traits strongly associated with LS (Anglim et al., 2020; Hahn et al., 2013; Røysamb et al., 2018).

Another type of GE interplay is gene-environment correlation (rGE). This concept refers to genetic factors influencing exposure to different environments (Purcell, 2002; Sauce & Matzel, 2018). Individuals with particular genotypes for a trait are therefore more likely to experience particular environments. For example, individuals with a genetic predisposition to high sociability are more likely to seek out social situations and engage in activities that involve interacting with others. In fact, one recent study reconfirmed the finding that social support is moderately heritable and that the genes influencing it partly overlap with well-being (Pelt et al., 2023). A study by Wootton and colleagues (2017) explored the association between different well-being traits, including LS, and positive life events. They observed a trend of positive genetic correlation between these two(Wootton et al., 2017). This indicates that inheriting propensity for positive well-being-related traits may cause a person to seek environments in which positive life events are more likely and thus also maintain a higher level of well-being. This is also an example of rGE.

Gene-environment correlation is usually classified into three different types: passive, reactive (evocative) and active rGE (Jaffee & Price, 2008). Passive rGE refers to the association between the genotype a child inherits from his or her parents and the environment in which the child is raised (Jaffee & Price, 2008). This is because the heritable traits (of which some are passed on to the child) of the parents influence the family environment. People also actively select and shape their environments (active rGE) which in turn triggers responses to their behaviour (reactive rGE). These responses may further amplify or strengthen their genetically based dispositions (R. B. Nes, 2009). In classical twin studies, the process of active and reactive rGE will be included in the heritability estimate, heritability thus reflecting more than the direct genetic effects (R. B.

Nes & Røysamb, 2016). Moreover, in quantitative genetic designs, the effect of the other types of GE interplay will also often be concealed in the standard variance components (i.e. A, D, C, E) (R. B. Nes & Røysamb, 2016; Purcell, 2002).

In regard to LS, a portion of its heritability may arise from these types of gene-environment correlations and interactions. Examples include learnt habits or hobbies, or inherited wealth. These outcomes are not merely genetically predisposed, and they might be passed onto offspring due to factors related to the environment. The various types of interplay between genes and environment are a phenomenon to be addressed in heritability studies since it clearly has a potential to affect the results. It's also an important research question for future study.

3.4.4 The Biological Basis

The substantial evidence for the heritable component of LS (Bartels, 2015) suggests that it should be possible to identify genomic regions associated with it. However, while twin studies are a widely employed method in the study of the heritability of well-being, they do not offer insights into the specific genes that might contribute to the heritability of a particular trait. Over the past two decades, research into the relationship between molecular biological factors and well-being traits has grown significantly. Molecular genetics seeks to explore the causal pathways from specific DNA variants to a given phenotype (R. B. Nes & Røysamb, 2016) and there have indeed been many efforts to trace the path between genes and SWB (e.g. De Neve, 2011; De Neve et al., 2012; Gärtner et al., 2018; Ohtsubo et al., 2022; Okbay et al., 2016; Rietveld et al., 2013). Additionally, some studies have focused on biological factors apart from DNA, such as immune parameter activity and differences in neurotransmitter or hormone levels (Barraza et al., 2013; Bekkevold et al., 2023; Friedman & Ryff, 2012; Ironson et al., 2018; D. Kim et al., 2016). Associations between physiological markers and the measures of well-being are reported thoroughly in a recently published systematic review of 91 studies (de Vries et al., 2022).

Molecular genetics has applied a multitude of different research strategies. The earliest studies on the association between the components of SWB and specific genes have been genetic linkage analyses and association studies for candidate genes. The latter refers to a strategy that starts with a "candidate" gene believed to influence specific qualities that are related to the phenotype of interest (De Neve et al., 2012). It is then tested whether an allele or genotype occurs more often in a group possessing a particular phenotype than those without the phenotype, or in individuals with higher levels of a quantitative trait (De Neve et al., 2012; Lanktree & Hegele, 2018).

Serotonergic neurotransmission has been shown to have implications for, among others, cognition and emotional processing, Therefore, numerous candidate gene studies within the study of SWB have focused on 5-HTTLPR, a polymorphic region in SLC6A4 that codes for the serotonin transporter (5-HTT) (Canli & Lesch, 2007). The transcriptional activity of SLC6A4 is partly modulated by the structure of 5-HTTLPR. This polymorphic region is composed of two variants: a short allele (S) and a long allele (L) resulting in differential 5-HTT expression and function (Canli & Lesch, 2007). Individual studies and larger reviews have demonstrated that 5-HTTLPR is associated with depression, sensitivity to motivationally relevant stimuli and, for example, neuroticism (Beevers et al., 2011; Delli Colli et al., 2022; Pluess et al., 2010; Røysamb & Nes, 2018). These are among the correlates of SWB and LS, thus suggesting the relevance of 5-HTTLPR to these concepts.

An early case-control genetic association study (n = 2,574) found that being homozygous for the long allele (L) for serotonergic expression and function resulted in significantly higher levels of LS compared to heterozygotes and further, to those homozygous for the short allele (S) (De Neve, 2011). However, a subsequent study on an augmented sample from the same data failed to replicate the result and provided mixed evidence instead (De Neve et al., 2012).

The significance of having a certain polymorphism in 5-HTTLPR is demonstrated in some other later studies. One study revealed that immigrants (n = 1,360) from countries with a higher prevalence of the 5-HTT long allele genotype tend to be more satisfied with their life after relocating and settling to the new country in comparison to migrants from countries with a lower prevalence of the 5-HTT long allele genotype (Kashima et al., 2015). Broadly speaking, the long

allele was more prevalent in individualistic and less hierarchical cultures, such as those in Western countries, compared to the more collectivist and hierarchical cultures found in many Asian nations. The genotypic effect even grew over time, as individuals from countries where the 5-HTT was more prevalent became more satisfied, meanwhile those from countries with a lower prevalence of the 5-HTT long allele remained stable. Another study, although with a very limited sample size (n = 92), found similarly that individuals with long polymorphisms reported greater LS compared to those with short polymorphisms (Matsunaga et al., 2013).

Research suggests that the 5-HTTLPR variant could possibly modulate the sensitivity to both positive and negative stimuli and be related to stress and depression (Beevers et al., 2011; Cahill et al., 2022; Cline et al., 2015; Gärtner et al., 2018; Karg et al., 2011; Kuepper et al., 2012; Kuhn et al., 2021; R. Miller et al., 2013). In a review by Røysamb and Nes (2018) this connection was pointed out as a potential explanation for the link between the serotonin transporter gene and well-being (Røysamb & Nes, 2018). The general finding is that individuals with the short variant of the serotonin transporter linked polymorphic region are more susceptible to environmental stimuli and stress compared to individuals homozygous for the long allele. Some studies have, however, found no supporting evidence for this (Ohtsubo et al., 2022; Rutter et al., 2009). For example, one study (n = 994) reported that the 5-HTTLPR alone was not associated with LS although a greater cumulative genetic score of many serotonergic polymorphisms was (Fan et al., 2023).

Genome-wide association studies (GWAS) are an emerging approach to heritability studies. GWAS sequence all or most of the genome in a large group of individuals and aim to identify specific genetic variants associated with a phenotype (e.g. SWB). The association found between each genetic variant and an outcome of interest is then carefully tested, thereby reducing the chance of false positives (Bartels, 2022; Røysamb & Nes, 2018). In a significant GWAS of SWB (n = 298,420) Okbay and colleagues (2016) identified three genetic loci associated with SWB (Okbay et al., 2016). These three genetic loci accounted for only 4% in heritability. The authors note that the effect sizes in this study suggest that likely thousands of variants will be needed to explain even a modest portion of the heritability estimated in previous studies. The analysis encompassed measures of LS and positive affect indicating that the findings might be applicable

to aspects related to LS. On the other hand, mixing different measures makes the discovered associations also more difficult to interpret.

Inspired by the findings of Okbay and colleagues (2016) and previous studies indicating a connection between the 5-HTTLPR polymorphism and SWB, a recent study sought to investigate these associations further (Lachmann et al., 2021). The study explored the association between three genetic variants and LS derived from the GWAS by Okbay and colleagues (2016). In addition, 5-HTTLPR was also assessed in connection with LS. The study found associations between one of the single nucleotide polymorphisms and LS. They also replicated previous findings involving 5-HTTLPR and LS but only for some specific LS variables (housing, leisure and family), not overall LS. The carriers of the long allele genotype scored higher on some subsets of LS compared to those carrying at least one short allele.

There are also some other studies exploring the genetics of LS. These studies have reported additional genetic regions linked to LS, either in the genome or epigenome (Baselmans, 2015; Baselmans et al., 2019). Interestingly, one GWAS also investigated if LS shares genetic aetiology with genes related to an alcohol use disorder (AUD) (Bountress, 2023). The results indicated that LS is associated with genes related to alcohol use but not alcohol use disorder.

In addition to the genetic approaches, some studies have focused on alternative biological aspects of the human body to understand the factors behind LS and well-being. These include variations in hormone levels, neurotransmitters, and immunological markers such as CRP and interleukin-6, as well as differences in brain morphology. For instance, in a recently published (2022) systematic review, the meta-analysis showed a small negative correlation between average momentary level of cortisol and different well-being indicators (de Vries et al., 2022). The review also reported that a more rapid decrease in cortisol levels throughout the day is associated with higher well-being, a finding also repeated in a study specifically examining LS (Zilioli et al., 2015). While the vast majority of studies exploring hormones and well-being have centred around cortisol, other hormones like oxytocin have also been studied in relation to LS (Barraza et al., 2013).

Multiple studies report that inflammatory markers, most commonly measured as C-reactive protein (CRP) and interleukin-6 (IL-6), are negatively related to well-being when assessed as positive affect, quality of life or LS (Bekkevold et al., 2023; Friedman & Ryff, 2012; Ironson et al., 2018; Ong et al., 2018; Steptoe et al., 2008). One study found that LS was significantly associated with CRP even after controlling for demographics and depression (n = 1,979) (Ironson et al., 2018). Another study with a large sample size (n = 68,769) displayed weak evidence that increased CRP may modestly reduce LS (Bekkevold et al., 2023). These results are compatible with the findings in the systematic review by de Vries and colleagues (de Vries et al., 2022). Not all independent studies, however, confirm these findings (e.g. Carpenter et al., 2012).

When investigating the brain, the focus can be on either its function or the structure. In terms of function, neurotransmitters like dopamine, serotonin, and (nor)epinephrine have been linked to mood and well-being. According to two systematic reviews and the World Happiness report of 2022, the results are mixed (Bartels, 2022; de Vries et al., 2022; Farhud et al., 2014). Some studies suggest that higher blood levels of serotonin may be related to better well-being, but there is no evidence supporting the significance of other neurotransmitters for well-being, or they have not yet been thoroughly investigated. The relationship between brain structure and well-being is also an area with limited research, especially when it comes to LS specifically, which has often been studied as part of the broader concept of SWB. In short, some studies suggest a potential link between brain morphology and SWB (Van ‘t Ent et al., 2017; Song et al., 2019).

4. Discussion

This review summarised the research on the heritability of life satisfaction. The main finding is that life satisfaction is significantly influenced by genetic factors. Results from predominantly twins studies demonstrate some variation in the heritability estimates, though they are usually in the range of 30-40% (Bartels, 2015; Røysamb et al., 2018, 2023; Stubbe et al., 2005). While the genetic influence is substantial, research also underlines the importance of environmental factors and variation for life satisfaction. Moreover, life satisfaction and its heritability have been shown to vary across different contexts, thus displaying the interplay between genes and environments.

Numerous studies provide heritability estimates for LS (Bartels, 2015; R. B. Nes et al., 2008; Røysamb et al., 2018, 2023; Stubbe et al., 2005). The largest meta-analysis reviewing 10 independent studies reported genetic effects to account for 32% (95 % CI: 29-35) of the variation in LS (n = 47,750) (Bartels, 2015). Several independent studies, along with the study of the broader concept of subjective well-being, have replicated these results showing notable consistency (Bartels & Boomsma, 2009; De Neve et al., 2013; Gatt et al., 2014; Hahn et al., 2013; Jamshidi et al., 2020; R. B. Nes et al., 2013; R. B. Nes & Røysamb, 2015; Pelt et al., 2023; Røysamb et al., 2018, 2023; Wootton et al., 2017). However, there are also studies that report a heritability of up to 67 % (Konkolÿ Thege et al., 2017) or, on the other hand, as low as 19% (Franz et al., 2012) or even zero (Harris et al., 1992). Taking a different approach, one study viewed LS as a persistent trait and reported a heritability of 72% (Nes et al., 2013).

Findings on the heritability of LS exhibit a fair uniformity, but questions remain about the sources of variance in the results. One common factor among the studies reporting divergent estimations is typically a small sample size. Smaller sample sizes increase the likelihood of selecting a group not accurately representing the broader population. For example, a sample might unintentionally include individuals from very similar backgrounds, resulting in bias when some characteristics are overrepresented or underrepresented. Another reasonable concern is the variety in well-being questionnaires and scales used across studies. This complicates the comparison of results from different studies. Single-item scales, for instance, may not capture the nuanced aspects of LS, leading to oversimplification and unreliability. Fortunately, several

studies have reported high reliability for the scales used overall (Cheung & Lucas, 2014; López-Ortega et al., 2016).

The factors discussed above might partly explain why the estimates of additive and non-additive genetic influences vary considerably. Studies report mixed results, some showing only non-additive genetic effects and others reporting mainly additive genetic effects (Bartels, 2015; Bartels & Boomsma, 2009; Hahn et al., 2013). This influences practical application. Because non-additive genetic effects involve interactions between alleles and genes, the presence of a particular allele associated with a trait does not necessarily result in straightforward influences. This complicates the prediction and manipulation of the trait in practice such as genetic counselling or personalised medicine. Additive effects would generally allow for more straightforward intervention. Since multiple studies indicate non-additive genetic influences, the genetic foundation of LS is likely shaped by a combination of both additive and non-additive genetic effects. This calls for more complex models and approaches for effective well-being interventions.

As already addressed earlier in the review, classical twin models are often not powerful enough to reliably detect the distinction between additive and non-additive genetic effects. This would require very large sample sizes and preferably more data from many different genetic relationships (e.g. siblings, parent-offspring). Studies including a broader range of family members beyond just twins have reported mixed findings but pointed towards the presence of non-additive genetic influences (Bartels & Boomsma, 2009; Hahn et al., 2013; Stubbe et al., 2005). In the future, more advanced genetic analyses, including molecular genetic studies, can be employed to separate between the additive and non-additive genetic effects of LS.

In addition to highlighting the importance of genes in determining LS, the studies also provide deeper insights and uncover many interesting aspects of this genetic influence. Findings indicate that the heritability of LS varies across different subgroups and in different environments. Heritability has been found to vary across sex (R. B. Nes, Czajkowski, et al., 2010; R. B. Nes et al., 2008; R. B. Nes, Røysamb, et al., 2010; Whisman et al., 2014), marital status (R. B. Nes, Røysamb, et al., 2010; Whisman et al., 2014), level of social support (R. B. Nes, Czajkowski, et

al., 2010; Pelt et al., 2023), socioeconomic status (Johnson & Krueger, 2006), and potentially even age (Harris et al., 1992; Stubbe et al., 2005). The ways by which genes could affect LS differently in males and females are still unknown. Genes may have a direct effect through differences in the DNA or they could operate indirectly through various pathways. For example, cultural factors might impact males and females in different ways. Societal expectations and cultural norms could interact with genetic predispositions, potentially leading to differences in how LS is experienced across sexes. Qualitative sex-differences should be systematically explored in future research in order to identify possible sex-specific genes or other contributing environmental factors.

The finding that the heritability of LS varies at different levels of social support is important. Both LS and SWB have been found to demonstrate a higher heritability among single individuals compared to those who are married (R. B. Nes, Røysamb, et al., 2010; Whisman et al., 2014). Similarly, a recent study found that the heritability of LS decreases as social support increases (Pelt et al., 2023). As Pelt and colleagues suggest, in stable environments with high levels of social support and fewer stressors, genetic differences may be less noticeable, resulting in behaviour that is more influenced by the situational context and overall disposition. Conversely, unmarried individuals and those with lower levels of social support may experience greater social vulnerability and external challenges, making their well-being more reliant on genetic predispositions. This variation in the heritability of LS across different levels of social support highlights the significance of environmental factors and social support in shaping LS. It suggests that genetic predispositions can be either amplified or suppressed depending on environmental conditions.

One might assume that, similar to social support, other positive factors could also dispel the role of genetic predispositions. However, this appears not to be the case, at least with financial resources. One study found higher heritability estimates among those more financially privileged (Johnson & Krueger, 2006). The authors proposed that individuals with fewer financial resources are more at the mercy of whatever circumstances come their way, while greater financial resources act as a buffer, mitigating (negative) environmental influences on LS. Taken together, it appears that different environmental circumstances can either increase or decrease the effect

that genes have on LS—another key finding of this literature review. This is a clear illustration of the gene-environment interplay, where neither of these operate independently but rather in deep cooperation with the other.

The demonstration of gene-environment interplay, where genetic influences of LS are not fixed from birth but depend on the environmental context, is an important finding. This opens up yet another opportunity for interventions—once a deeper understanding of the complex mechanisms has been established. Genes both alter a person's sensitivity to environmental features as well as increase the likelihood of them creating and choosing specific environments. In classical twin studies, these phenomena are unfortunately concealed in the standard variance components and only separate estimations for genetic and environmental effects are provided. This leaves a significant area largely unexplored.

The gene-environment interplay raises many practical questions about how genetic dispositions might interact with cultures and societies, their values and customs, as well as physical resources. As Røysamb and colleagues (2023) propose, some cultures may value certain human characteristics (e.g. extraversion or academic achievement) differently, leading to variations in the genetic factors influencing well-being across cultures (Røysamb et al., 2023). Education is another example: if equal educational opportunities were available for everyone, they could enable individuals' genetic potential for learning to thrive, potentially enhancing their well-being. Of course, a single area like education benefits some individuals more than others. This raises the question of how to create environmental conditions where individuals' diverse genetic potentials can be equally expressed and nourished.

Personality is an intriguing and essential area related to the genetics of LS. The genetic effects of LS have been closely linked to personality through shared genes (Hahn et al., 2013; Okbay et al., 2016; Røysamb et al., 2018; Weiss et al., 2008, 2016). Some studies have even suggested LS to be genetically completely indistinct from personality traits (Hahn et al., 2013; Weiss et al., 2008). The connection is especially strong with the genes influencing neuroticism and extraversion. These genes are likely to operate both directly and indirectly. Our personality, which is partly heritable, shapes our general outlook on the world. In addition, people interact

with their environment in a way that is compatible with their partially genetically predisposed personality. These events could both further affect LS.

Since the link between LS and personality is strong, it seems like a good target for practical application. For instance, individuals with certain personality profiles might be guided towards specific types of counselling or lifestyle changes based on their inherent dispositions. A more neurotic person, for example, might benefit from strategies that target anxiety and stress management, which could, in turn, enhance their overall LS. On the other hand, personality traits are moderately stable throughout the lifespan. Therefore, some interventions aimed at them might be ineffective. In addition, the significance of different personality characteristics for LS likely varies across cultures, which should be acknowledged when designing these interventions.

As has been observed, genetics have a substantial influence on LS, but ultimately, environmental factors play a bigger role. Environmental effects account for 60-70% of the variance in LS. Well established influences include social support and the effect of life events such as marriage, unemployment or divorce (Bühler et al., 2023; Lucas, 2007; Pelt et al., 2023; Warmerdam et al., 2022; Whisman et al., 2014). One might assume that parenting style, family income or neighbourhood factors could also have an effect. However, although counterintuitive, studies do not support this. This leads us to the debated question in behavioural genetics: what kind of role do shared environmental factors have for well-being?

Quantitative genetic studies commonly show that environmental effects are unique to each individual, with similarities between family members attributed to shared genes rather than shared environments. However, this prevailing view has been challenged by some studies that indicate the presence of shared environmental effects (Caprara et al., 2009; Franz et al., 2012; Hahn et al., 2013; Haworth et al., 2017; Hufer-Thamm & Riemann, 2021; Johnson & Krueger, 2006; R. B. Nes et al., 2008; Røysamb et al., 2023; Whisman et al., 2014; Wootton et al., 2017). Røysamb and colleagues (2023) have recently presented evidence and interesting ideas on this topic (Røysamb et al., 2023). They propose that previous studies may have failed to capture shared environmental effects due to their focus on too homogenous, within-country samples. Instead, well-being should be examined from a global perspective, where country-specific

factors such as healthcare systems, national economies, governance, corruption, and conflict would serve as shared environmental influences. In this context, shared environmental effects would manifest on a broader scale, beyond just family resemblance.

The absence of shared environment effects does not mean that environmental factors common to siblings are irrelevant to LS and well-being. The findings rather indicate that factors like parenting style or access to education may impact different siblings differently, making these non-shared environmental factors. Additionally, as with non-additive genetic influences, the lack of detectable shared environmental effects might be due to the limited power of classical twin designs to identify these variance components. The C (shared environmental effects) and D (non-additive genetic effects) components are often confounded, requiring one to be fixed at zero, even if both influences are present (Hahn et al., 2013; Posthuma & Boomsma, 2000). Finally, LS is shaped by complex interactions and correlations between genetic and environmental influences, complicating the study of heritability and making it challenging to draw definitive conclusions.

There seems to be evidence for shared environmental influences on LS. Overall, environmental effects appear to make up the most in determining LS levels. This suggests that many changeable factors could potentially enhance or lower LS. A deeper understanding of shared environmental influences is needed, as it could guide whether interventions should be broad and community-based or highly individualised. If LS is primarily shaped by unique environmental factors, interventions aiming to affect LS would need to be tailored for individual needs and circumstances. In contrast, if shared environmental factors have a more significant influence, interventions targeted at larger groups such as neighbourhoods or other communities and whole societies, can have broad-reaching effects, benefiting multiple individuals simultaneously. Research in this area would be particularly valuable for health authorities and policymakers.

Given the findings from twin-family studies indicating a genetic component for LS, it has been natural to explore the specific genes that might contribute to well-being. Molecular genetics, while steadily growing, remains a relatively new field with significant aspects yet to be uncovered. Although some potential genetic variants have been found, altogether they only

explain a small fraction of the variance in well-being. A phenomenon like LS is likely to be too multifactorial, polygenic and pleiotropic to be linked to specific and straightforward genetic factors. Even if there are no precise “happiness genes” as such, it does not imply that more research about the molecular basis of well-being is useless. Better knowledge about the underlying biological processes could help to understand the foundations of a fulfilling and good life, and find ways to achieve it.

LS is strongly associated with overall well-being, including physical and mental health (Diener & Chan, 2011; E. S. Kim et al., 2021; Ngamaba et al., 2017). Satisfied individuals live longer and visit the doctor and mental health services less frequently (Diener et al., 2017; Diener & Chan, 2011; E. S. Kim et al., 2014; Michalski et al., 2022; Ngamaba et al., 2017). LS can also protect against mental illness and serve as an indicator for those at the risk of developing mental health problems (Koivumaa-Honkanen et al., 2001, 2004, 2011; Lombardo et al., 2018). Furthermore, higher satisfaction and SWB can support positive health behaviours, such as regular exercise and healthy eating habits (E. S. Kim et al., 2021; Stenlund, 2022). The relationship between LS and health appears to be bidirectional: better health predicts LS, but satisfied individuals also tend to be healthier. Since findings indicate that LS is largely influenced by environmental factors, improving both health and LS should be possible—as formulated by Ackerman (2018) ”increase or enhance one, and the other will likely soon follow” (Ackerman, 2018).

4.2 Implications

What does the significant heritability of LS found in this literature review imply in practice? First, it helps to build understanding of individual differences. Acknowledging genetic contributions to LS explains why people experience different levels of psychological well-being, even under similar circumstances. This proves that people cannot simply decide to be happy and content—some people are born with genetically favourable predispositions for it.

On the other hand, while genes do have a significant effect on LS, they only account for a portion of it. The findings highlight the importance of gene-environment interplay and the role of unique environments. Encouraging results show that LS and its heritability can vary in different groups, settings and environments, suggesting that LS can be enhanced by altering environmental conditions. Given the mounting evidence linking LS to positive mental and physical health outcomes, this opens a valuable opportunity for developing targeted interventions and policies. Health authorities, policymakers, and governments should recognize the role of environments in influencing LS and psychological well-being when making decisions about, for example, education, social support, healthcare and urban planning. In fact, some authorities have already provided evidence, guidelines, and recommendations to governments to promote happiness and well-being (The Global Happiness Council, 2022). Creating the right kind of environments can significantly affect individual LS, and in turn, contribute to the health and flourishing of entire societies.

4.3 Strengths and Weaknesses

This literature review is based on a substantial body of studies using various study designs and methods. The exploration of several areas related to the heritability of LS has helped to provide a comprehensive overview and pay attention to different perspectives. Because of the large number of studies, the amount of overall data is big and the study populations stem from diverse origins, including people from different countries and of different ages. The review emphasises the most recently published articles, ensuring the relevance and currency of the literature.

While there were study samples from different countries, most of the study populations were from Western Europe and North America. This limits the ability to generalise the findings globally to other populations. Moreover, many studies had relatively small sample sizes. Combined with the heavy reliance on voluntary participation, there is a concern that the samples may not fully represent the broader population, further restricting the generalisability of the results.

A specific weakness related to the studies reviewed, lies in the study designs. Most of the studies are cross-sectional i.e. they estimate heritability, LS and genetic factors at a single point in time using twin and sibling samples. However, despite the advantages of cross-sectional studies, they have certain issues when applied to heritability research. Since cross-sectional studies measure all variables at the same time, causality cannot be assessed. In addition, the lack of longitudinal dimension prevents these studies from capturing the impact of life events and transitions, although it is well acknowledged that LS can be significantly influenced by major life changes (Bühler et al., 2023).

The statistical methods employed in twin studies also have some limitations. Classical twin models often have difficulty to detect shared environmental influences or to differentiate between additive and non-additive genetic effects. Thus, twin studies are most reliable when estimating only broad sense heritability. This may lead to neglect of non-additive genetic influences when studies focus only on additive genetic effects. This reflects a larger problem in quantitative genetic studies: genetic and environmental factors are assumed to be independent. In reality, a dynamic interplay exists between these two, and heritability is thus much more complex. Different studies have decided to employ different models, which further complicates the comparison of the results.

A challenge to consider is the concept and measurement of LS itself. LS is a complex trait, and different studies use various scales and questionnaires to measure it. The inconsistency in the measures might result in nuance differences that affect the comparability of results. Furthermore, as the focus was specifically on LS, many other constructs relevant to psychological well-being might have been neglected. These include qualities such optimism, sense of coherence and the emotional components of SWB. Finally, although the literature review was extensive, it wasn't systematically done. This makes it prone to subjectivity, and it is possible that some important studies may have been overlooked.

4.4 Future Directions

Positive psychology and the study of LS are relatively new fields with considerable opportunities for further exploration and discovery. Currently, most of the studies on the heritability of LS are cross-sectional or short prospective studies. Therefore, long-term longitudinal designs are needed to observe how genetic and environmental influences on LS change across lifespan. LS can fluctuate, and an understanding how major life events interact with genetic predispositions can give more information than the snapshots from cross-sectional studies. Future studies should also include multiple family relationships (e.g. parent-child, grandparent-child), in addition to the twins, to get more accurate data and more reliable heritability estimates. At the moment, most studies focus on only twin-pairs.

Another important direction for the future would be to examine the complicated interplay between genes and the environment. The studies should focus on identifying specific environmental factors, such as social support or education, that interact with genetic predispositions. This would mean examining gene-environment interactions and correlations, as well as epigenetics. As molecular genetics advances, these techniques should also be utilised. They would have a potential to give insights of the causal pathways and biological basis between genes and LS.

Since the majority of heritability studies are based on Western populations, it is essential to include more diverse cultural and ethnic groups in future research. The estimates together would be more representative of the global population and the possible variation in heritability could help clarify how different environments and contexts influence LS. Furthermore, given the variability in heritability estimates, conducting meta-analyses that synthesise data from multiple studies are always useful. In order to do this, it would be beneficial to standardise measurement tools. Consistent, comprehensive measures would improve the comparability of results from different studies.

4.5 Conclusion

Life satisfaction is influenced significantly by genetic factors. While there is evidence of substantial heritability, the genetic influence is not deterministic and no single happiness-causing genes have been found. Studies show some variation in the heritability estimates, though they are mainly set in the range of 30-40%. Research points at the major role of environmental factors and variation in influencing life satisfaction. Unique environments experienced by individuals seem to be particularly important, leaving a promising space for intervention. Genes and environments are also found to interact in complex and so far mostly unknown ways. This is a key direction for future research – to uncover the mechanisms and interactions by which specific genes and environments shape life satisfaction and well-being. A deeper understanding of the role of genes in determining life satisfaction can help policy makers consider how policies affect the well-being of citizens.

References

Acar, S., Tadik, H., Myers, D., Van Der Sman, C., & Uysal, R. (2021). Creativity and Well-being: A Meta-analysis. *The Journal of Creative Behavior*, *55*(3), 738–751. https://doi.org/10.1002/jocb.485

Ackerman, Courtney E. (2018, November 6). *Life Satisfaction Theory & 4 Contributing Factors (+ Scale)*. PositivePsychology.Com. https://positivepsychology.com/life-satisfaction/

Adedeji, A., Idemudia, E. S., Bolarinwa, O. A., & Metzner, F. (2021). Racial relations and life satisfaction among South Africans: Results from the 2017 South African Social Attitudes Survey (SASAS). *Journal of Psychology in Africa*, *31*(5), 522–528. https://doi.org/10.1080/14330237.2021.1978183

Amati, V., Meggiolaro, S., Rivellini, G., & Zaccarin, S. (2018). Social relations and life satisfaction: The role of friends. *Genus*, *74*(1), 7. https://doi.org/10.1186/s41118-018-0032-z

Anglim, J., Horwood, S., Marrero, R. J., Smillie, L. D., & Wood, J. K. (2020). *Predicting Psychological and Subjective Well-Being From Personality: A Meta-Analysis*.

Anreiter, I., Sokolowski, H. M., & Sokolowski, M. B. (2018). Gene–Environment Interplay and Individual Differences in Behavior. *Mind, Brain, and Education*, *12*(4), 200–211. https://doi.org/10.1111/mbe.12158

Anusic, I., & Schimmack, U. (2016). Stability and change of personality traits, self-esteem, and well-being: Introducing the meta-analytic stability and change model of retest correlations. *Journal of Personality and Social Psychology*, *110*(5), 766–781. https://doi.org/10.1037/pspp0000066

APA Dictionary of Psychology. (2018). https://dictionary.apa.org/

Ash, C., & Huebner, E. S. (2001). Environmental Events and Life Satisfaction Reports of Adolescents: A Test of Cognitive Mediation. *School Psychology International*, *22*(3), 320–336. https://doi.org/10.1177/0143034301223008

Assary, E., Zavos, H. M. S., Krapohl, E., Keers, R., & Pluess, M. (2021). Genetic architecture of Environmental Sensitivity reflects multiple heritable components: A twin study with adolescents. *Molecular Psychiatry*, *26*(9), 4896–4904. https://doi.org/10.1038/s41380-020-0783-8

Badri, M. A., Alkhaili, M., Aldhaheri, H., Yang, G., Albahar, M., & Alrashdi, A. (2022). Exploring the Reciprocal Relationships between Happiness and Life Satisfaction of Working Adults—Evidence from Abu Dhabi. *International Journal of Environmental Research and Public Health*, *19*(6), 3575. https://doi.org/10.3390/ijerph19063575

Barraza, J. A., Grewal, N. S., Ropacki, S., Perez, P., Gonzalez, A., & Zak, P. J. (2013). Effects of a 10-day oxytocin trial in older adults on health and well-being. *Experimental and Clinical Psychopharmacology*, *21*(2), 85–92. https://doi.org/10.1037/a0031581

Bartels. (2022). *Exploring the Biological Basis for Happiness*. https://worldhappiness.report/ed/2022/exploring-the-biological-basis-for-happiness/

Bartels, M. (2015). Genetics of Wellbeing and Its Components Satisfaction with Life, Happiness, and Quality of Life: A Review and Meta-analysis of Heritability Studies. *Behavior Genetics*, *45*(2), 137–156. https://doi.org/10.1007/s10519-015-9713-y

Bartels, M., & Boomsma, D. I. (2009). Born to be Happy? The Etiology of Subjective Well-Being. *Behavior Genetics*, *39*(6), 605–615. https://doi.org/10.1007/s10519-009-9294-8

Bartels, M., Saviouk, V., de Moor, M. H. M., Willemsen, G., van Beijsterveldt, T. C. E. M., Hottenga, J.-J., de Geus, E. J. C., & Boomsma, D. I. (2010). Heritability and genome-wide linkage scan of subjective happiness. *Twin Research and Human Genetics: The Official Journal*

of the International Society for Twin Studies, *13*(2), 135–142. https://doi.org/10.1375/twin.13.2.135

Bartram, D. (2021). Age and Life Satisfaction: Getting Control Variables under Control. *Sociology*, *55*(2), 421–437. https://doi.org/10.1177/0038038520926871

Baselmans, B. M. L. (2015). Epigenome-Wide Association Study of Wellbeing. *Https://Www.Cambridge.Org/Core/Journals/Twin-Research-and-Human-Genetics/Article/Epigenomewide-Association-Study-of-Wellbeing/ACF2C7937B95DD661BCAB229A6661AE3*.

Baselmans, B. M. L., Jansen, R., Ip, H. F., van Dongen, J., Abdellaoui, A., van de Weijer, M. P., Bao, Y., Smart, M., Kumari, M., Willemsen, G., Hottenga, J.-J., Boomsma, D. I., de Geus, E. J. C., Nivard, M. G., & Bartels, M. (2019). Multivariate genome-wide analyses of the well-being spectrum. *Nature Genetics*, *51*(3), 445–451. https://doi.org/10.1038/s41588-018-0320-8

Becchetti, L., & Conzo, G. (2022). The Gender Life Satisfaction/Depression Paradox. *Social Indicators Research*, *160*(1), 35–113. https://doi.org/10.1007/s11205-021-02740-5

Beevers, C. G., Marti, C. N., Lee, H.-J., Stote, D. L., Ferrell, R. E., Hariri, A. R., & Telch, M. J. (2011). Associations between serotonin transporter gene promoter region (5-HTTLPR) polymorphism and gaze bias for emotional information. *Journal of Abnormal Psychology*, *120*(1), 187–197. https://doi.org/10.1037/a0022125

Bekkevold, O.-J., Damås, J. K., Brumpton, B. M., & Åsvold, B. O. (2023). The causal role of C-reactive protein and interleukin-6 on anxiety and depression symptoms and life satisfaction: Mendelian randomisation analyses in the HUNT study. *Psychological Medicine*, 1–8. https://doi.org/10.1017/S0033291723001290

Bishop, A. J., Martin, P., & Poon, L. (2006). Happiness and congruence in older adulthood: A structural model of life satisfaction. *Aging & Mental Health*, *10*(5), 445–453. https://doi.org/10.1080/13607860600638388

Blanchflower, D. G., & Oswald, A. J. (2008). Is well-being U-shaped over the life cycle? *Social Science & Medicine*, *66*(8), 1733–1749. https://doi.org/10.1016/j.socscimed.2008.01.030

Bleidorn, W., Hopwood, C. J., Back, M. D., Denissen, J. J. A., Hennecke, M., Hill, P. L., Jokela, M., Kandler, C., Lucas, R. E., Luhmann, M., Orth, U., Roberts, B. W., Wagner, J., Wrzus, C., & Zimmermann, J. (2021). Personality trait stability and change. *Personality Science*, *2*, e6009. https://doi.org/10.5964/ps.6009

Bleidorn, W., Schwaba, T., Zheng, A., Hopwood, C. J., Sosa, S. S., Roberts, B. W., & Briley, D. A. (2022). Personality stability and change: A meta-analysis of longitudinal studies. *Psychological Bulletin*, *148*(7–8), 588–619. https://doi.org/10.1037/bul0000365.supp

Bottoni, G., & Addeo, F. (2024). The Effect of Social Cohesion on Subjective Individual Quality of Life in European Countries. *Social Indicators Research*, *171*(3), 1111–1133. https://doi.org/10.1007/s11205-023-03284-6

Bountress, K. E. (2023, August 18). *Genetic associations between alcohol phenotypes and life satisfaction: A genomic structural equation modelling approach*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10439217/

Bryson, A., Forth, J., & Stokes, L. (2017). Does employees' subjective well-being affect workplace performance? *Human Relations*, *70*(8), 1017–1037. https://doi.org/10.1177/0018726717693073

Bühler, J. L., Orth, U., Bleidorn, W., Weber, E., Kretzschmar, A., Scheling, L., & Hopwood, C. J. (2023). Life Events and Personality Change: A Systematic Review and Meta-Analysis. *European Journal of Personality*, 08902070231190219. https://doi.org/10.1177/08902070231190219

Busseri, M. A., & Erb, E. M. (2022). The happy personality revisited: Re-examining associations between Big Five personality traits and subjective well-being using meta-analytic structural equation modeling. *Journal of Personality*, *n/a*(n/a). https://doi.org/10.1111/jopy.12862

Cahill, S., Chandola, T., & Hager, R. (2022). Genetic Variants Associated With Resilience in Human and Animal Studies. *Frontiers in Psychiatry*, *13*, 840120. https://doi.org/10.3389/fpsyt.2022.840120

Canli, T., & Lesch, K.-P. (2007). Long story short: The serotonin transporter in emotion regulation and social cognition. *Nature Neuroscience*, *10*(9), Article 9. https://doi.org/10.1038/nn1964

Caprara, G. V., Fagnani, C., Alessandri, G., Steca, P., Gigantesco, A., Sforza, L. L. C., & Stazi, M. A. (2009). Human Optimal Functioning: The Genetics of Positive Orientation Towards Self, Life, and the Future. *Behavior Genetics*, *39*(3), 277–284. https://doi.org/10.1007/s10519-009-9267-y

Carpenter, L. L., Gawuga, C. E., Tyrka, A. R., & Price, L. H. (2012). C-reactive protein, early life stress, and wellbeing in healthy adults. *Acta Psychiatrica Scandinavica*, *126*(6), 402–410. https://doi.org/10.1111/j.1600-0447.2012.01892.x

Cheung, F., & Lucas, R. E. (2014). Assessing the Validity of Single-item Life Satisfaction Measures: Results from Three Large Samples. *Quality of Life Research : An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation*, *23*(10), 2809–2818. https://doi.org/10.1007/s11136-014-0726-4

Cline, J. I., Belsky, J., Li, Z., Melhuish, E., Lysenko, L., McFarquhar, T., Stevens, S., & Jaffee, S. R. (2015). Take your mind off it: Coping style, serotonin transporter linked polymorphic region genotype (5-HTTLPR), and children's internalizing and externalizing problems.

Development and Psychopathology, *27*(4 Pt 1), 1129–1143. https://doi.org/10.1017/S0954579415000723

De Neve, J.-E. (2011). Functional polymorphism (5-HTTLPR) in the serotonin transporter gene is associated with subjective well-being: Evidence from a US nationally representative sample. *Journal of Human Genetics*, *56*(6), 456–459. https://doi.org/10.1038/jhg.2011.39

De Neve, J.-E., Christakis, N. A., Fowler, J. H., & Frey, B. S. (2012). Genes, Economics, and Happiness. *Journal of Neuroscience, Psychology, and Economics*, *5*(4), 10.1037/a0030292. https://doi.org/10.1037/a0030292

De Neve, J.-E., Diener, E., Tay, L., & Xuereb, C. (2013). *The Objective Benefits of Subjective Well-Being* (SSRN Scholarly Paper 2306651). https://papers.ssrn.com/abstract=2306651

de Vries, L. P., van de Weijer, M. P., & Bartels, M. (2022). The human physiology of well-being: A systematic review on the association between neurotransmitters, hormones, inflammatory markers, the microbiome and well-being. *Neuroscience & Biobehavioral Reviews*, *139*, 104733. https://doi.org/10.1016/j.neubiorev.2022.104733

Deaton, A. (2008). Income, Health and Wellbeing Around the World: Evidence from the Gallup World Poll. *The Journal of Economic Perspectives : A Journal of the American Economic Association*, *22*(2), 53–72. https://doi.org/10.1257/jep.22.2.53

Deaton, A., & Stone, A. A. (2016). Understanding context effects for a measure of life evaluation: How responses matter. *Oxford Economic Papers*, *68*(4), 861–870. https://doi.org/10.1093/oep/gpw022

Delli Colli, C., Borgi, M., Poggini, S., Chiarotti, F., Cirulli, F., Penninx, B. W. J. H., Benedetti, F., Vai, B., & Branchi, I. (2022). Time moderates the interplay between 5-HTTLPR and stress on depression risk: Gene x environment interaction as a dynamic process. *Translational Psychiatry*, *12*(1), Article 1. https://doi.org/10.1038/s41398-022-02035-4

DeNeve, K. M., & Cooper, H. (1998). The happy personality: A meta-analysis of 137 personality traits and subjective well-being. *Psychological Bulletin*, *124*(2), 197. https://doi.org/10.1037/0033-2909.124.2.197

Desmond, S. A., Kraus, R., & Dugan, B. J. L. (2018). "Let the heavens be glad, and the earth rejoice": Religion and life satisfaction among emerging adults in the United States. *Mental Health, Religion & Culture*, *21*(3), 304–318. https://doi.org/10.1080/13674676.2018.1478397

DFARHUD, D., MALMIR, M., & KHANAHMADI, M. (2014). Happiness & Health: The Biological Factors- Systematic Review Article. *Iranian Journal of Public Health*, *43*(11), 1468–1477.

Diener, E. (1984). *Subjective Well-Being* (SSRN Scholarly Paper 2162125). https://papers.ssrn.com/abstract=2162125

Diener, E. (1993). Review of the Satisfaction With Life Scale. In E. Diener (Ed.), *Assessing Well-Being: The Collected Works of Ed Diener* (pp. 101–117). Springer Netherlands. https://doi.org/10.1007/978-90-481-2354-4_5

Diener, E., & Chan, M. Y. (2011). Happy People Live Longer: Subjective Well-Being Contributes to Health and Longevity. *Applied Psychology: Health and Well-Being*, *3*(1), 1–43. https://doi.org/10.1111/j.1758-0854.2010.01045.x

Diener, E., & Diener, M. (1995). Cross-cultural correlates of life satisfaction and self-esteem. *Journal of Personality and Social Psychology*, *68*(4), 653–663. https://doi.org/10.1037//0022-3514.68.4.653

Diener, E., Inglehart, R., & Tay, L. (2013). Theory and Validity of Life Satisfaction Scales. *Social Indicators Research*, *112*(3), 497–527. https://doi.org/10.1007/s11205-012-0076-y

Diener, E., Ng, W., Harter, J., & Arora, R. (2010). Wealth and happiness across the world: Material prosperity predicts life evaluation, whereas psychosocial prosperity predicts positive feeling. *Journal of Personality and Social Psychology*, *99*(1), 52–61. https://doi.org/10.1037/a0018066

Diener, E., Oishi, S., & Tay, L. (2018). Advances in subjective well-being research. *Nature Human Behaviour*, *2*(4), 253–260. https://doi.org/10.1038/s41562-018-0307-6

Diener, E., Pressman, S. D., Hunter, J., & Delgadillo-Chase, D. (2017). If, Why, and When Subjective Well-Being Influences Health, and Future Needed Research. *Applied Psychology: Health and Well-Being*, *9*(2), 133–167. https://doi.org/10.1111/aphw.12090

Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin*, *125*(2), 276. https://doi.org/10.1037/0033-2909.125.2.276

DiMaria, C. H., Peroni, C., & Sarracino, F. (2020). Happiness Matters: Productivity Gains from Subjective Well-Being. *Journal of Happiness Studies*, *21*(1), 139–160. https://doi.org/10.1007/s10902-019-00074-1

Ehrhardt, J. J., Saris, W. E., & Veenhoven, R. (2000). Stability of Life-satisfaction over Time. *Journal of Happiness Studies*, *1*(2), 177–205. https://doi.org/10.1023/A:1010084410679

Fan, Y., Yang, Y., Shi, L., Zhao, W., Kong, F., & Gong, P. (2023). Genetic architecture of well-being: Cumulative effect of serotonergic polymorphisms. *Social Cognitive and Affective Neuroscience*, *18*(1), nsad039. https://doi.org/10.1093/scan/nsad039

Fergusson, D. M., McLeod, G. F. H., Horwood, L. J., Swain, N. R., Chapple, S., & Poulton, R. (2015). Life satisfaction and mental health problems (18 to 35 years). *Psychological Medicine*, *45*(11), 2427–2436. https://doi.org/10.1017/S0033291715000422

Fowler, S. A., Davis, L. L., Both, L. E., & Best, L. A. (2018). Personality and perfectionism as predictors of life satisfaction: The unique contribution of having high standards for others. *FACETS*, *3*(1), 227–241. https://doi.org/10.1139/facets-2017-0084

Franz, C. E., Panizzon, M. S., Eaves, L. J., Thompson, W., Lyons, M. J., Jacobson, K. C., Tsuang, M., Glatt, S. J., & Kremen, W. S. (2012). Genetic and Environmental Multidimensionality of Well- and Ill-Being in Middle Aged Twin Men. *Behavior Genetics*, *42*(4), 579–591. https://doi.org/10.1007/s10519-012-9538-x

Friedman, E. M., & Ryff, C. D. (2012). Living Well With Medical Comorbidities: A Biopsychosocial Perspective. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *67*(5), 535–544. https://doi.org/10.1093/geronb/gbr152

Fujita, F., & Diener, E. (2005). Life Satisfaction Set Point: Stability and Change. *Journal of Personality and Social Psychology*, *88*(1), 158. https://doi.org/10.1037/0022-3514.88.1.158

Gable, S. L., & Haidt, J. (2005). What (and Why) is Positive Psychology? *Review of General Psychology*, *9*(2), 103–110. https://doi.org/10.1037/1089-2680.9.2.103

Gärtner, M., Grimm, S., Aust, S., Fan, Y., von Scheve, C., & Bajbouj, M. (2018). The interplay of genetic and environmental factors in shaping well-being across the lifespan: Evidence from the serotonin transporter gene. *Aging & Mental Health*, *22*(9), 1222–1228. https://doi.org/10.1080/13607863.2017.1348467

Gatt, J. M., Burton, K. L. O., Schofield, P. R., Bryant, R. A., & Williams, L. M. (2014). The heritability of mental health and wellbeing defined using COMPAS-W, a new composite measure of wellbeing. *Psychiatry Research*, *219*(1), 204–213. https://doi.org/10.1016/j.psychres.2014.04.033

Graham, C., & Ruiz Pozuelo, J. (2017). Happiness, stress, and age: How the U curve varies across people and places. *Journal of Population Economics*, *30*(1), 225–264. https://doi.org/10.1007/s00148-016-0611-2

Grant, N., Wardle, J., & Steptoe, A. (2009). The Relationship Between Life Satisfaction and Health Behavior: A Cross-cultural Analysis of Young Adults. *International Journal of Behavioral Medicine*, *16*(3), 259–268. https://doi.org/10.1007/s12529-009-9032-x

Hahn, E., Johnson, W., & Spinath, F. M. (2013). Beyond the heritability of life satisfaction – The roles of personality and twin-specific influences. *Journal of Research in Personality*, *47*(6), 757–767. https://doi.org/10.1016/j.jrp.2013.07.003

Harris, J. R., Pedersen, N. L., Stacey, C., McClearn, G. E., & Nesselroade, J. R. (1992). Age Differences in the Etiology of the Relationship between Life Satisfaction and Self-Rated Health. *Journal of Aging and Health*, *4*(3), 349–368. https://doi.org/10.1177/089826439200400302

Haworth, C. M. A., Carter, K., Eley, T. C., & Plomin, R. (2017). Understanding the genetic and environmental specificity and overlap between well-being and internalizing symptoms in adolescence. *Developmental Science*, *20*(2), e12376. https://doi.org/10.1111/desc.12376

Headey, B., & Muffels, R. (2018). A Theory of Life Satisfaction Dynamics: Stability, Change and Volatility in 25-Year Life Trajectories in Germany. *Social Indicators Research*, *140*(2), 837–866. https://doi.org/10.1007/s11205-017-1785-z

Helliwell, J. F. (2003). How's life? Combining individual and national variables to explain subjective well-being. *Economic Modelling*, *20*(2), 331–360. https://doi.org/10.1016/S0264-9993(02)00057-3

Helliwell, J. F. (2006). Well-Being, Social Capital and Public Policy: What's New? *Economic Journal*, *116*(510), C34–C45. https://doi.org/10.1111/j.1468-0297.2006.01074.x

Helliwell, J. F., Huang, H., & Wang, S. (2014). Social Capital and Well-Being in Times of Crisis. *Journal of Happiness Studies*, *15*(1), 145–162. https://doi.org/10.1007/s10902-013-9441-z

Helliwell, J. F., Layard, R., & Sachs, J. D. (2019, March 20). *World Happiness Report 2019*. https://worldhappiness.report/ed/2019/

Helliwell, J. F., Layard, R., Sachs, J. D., Neve, J.-E. D., Aknin, L. B., & Wang, S. (2023, March 20). *World Happiness Report 2023*. https://worldhappiness.report/ed/2023/

Helliwell, J. F., & Putnam, R. D. (2004). The social context of well-being. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *359*(1449), 1435–1446. https://doi.org/10.1098/rstb.2004.1522

Hopwood, C. J., Donnellan, M. B., Blonigen, D. M., Krueger, R. F., McGue, M., Iacono, W. G., & Burt, S. A. (2011). Genetic and environmental influences on personality trait stability and growth during the transition to adulthood: A three wave longitudinal study. *Journal of Personality and Social Psychology*, *100*(3), 545–556. https://doi.org/10.1037/a0022409

Hudson, N. W., Lucas, R. E., & Donnellan, M. B. (2017). Day-to-day affect is surprisingly stable: A two-year longitudinal study of well-being. *Social Psychological and Personality Science*, *8*(1), 45–54. https://doi.org/10.1177/1948550616662129

Hufer-Thamm, A., & Riemann, R. (2021). On the link of self-esteem, life satisfaction, and Neuroticism. *Journal of Personality*, *89*(5), 998–1011. https://doi.org/10.1111/jopy.12632
Ironson, G., Banerjee, N., Fitch, C., & Krause, N. (2018). Positive emotional well-being, health Behaviors, and inflammation measured by C-Reactive protein. *Social Science & Medicine*, *197*, 235–243. https://doi.org/10.1016/j.socscimed.2017.06.020

Jaffee, S. R., & Price, T. S. (2008). Genotype–environment correlations: Implications for determining the relationship between environmental exposures and psychiatric illness. *Psychiatry*, *7*(12), 496–499. https://doi.org/10.1016/j.mppsy.2008.10.002

Jamshidi, J., Williams, L. M., Schofield, P. R., Park, H. R. P., Montalto, A., Chilver, M. R., Bryant, R. A., Toma, C., Fullerton, J. M., & Gatt, J. M. (2020). Diverse phenotypic measurements of wellbeing: Heritability, temporal stability and the variance explained by polygenic scores. *Genes, Brain and Behavior*, *19*(8). https://doi.org/10.1111/gbb.12694

Jebb, A. T., Tay, L., Diener, E., & Oishi, S. (2018). Happiness, income satiation and turning points around the world. *Nature Human Behaviour*, *2*(1), 33–38. https://doi.org/10.1038/s41562-017-0277-0

Johnson, W., & Krueger, R. F. (2006). How money buys happiness: Genetic and environmental processes linking finances and life satisfaction. *Journal of Personality and Social Psychology*, *90*(4), 680–691. https://doi.org/10.1037/0022-3514.90.4.680

Joshanloo, M. (2024). Level and stability of self-esteem mediate relationships between personality traits and life satisfaction: Bayesian multilevel modeling with annual data. *Cognition and Emotion*, *0*(0), 1–16. https://doi.org/10.1080/02699931.2024.2392615

Kahneman, D. (2010). *The Structure of Wellbeing in Two Cities: Life Satisfaction and Experienced Happiness in Columbus, Ohio; and Rennes, France.* https://worlddatabaseofhappiness.eur.nl/publications/the-structure-of-wellbeing-in-two-cities-life-satisfaction-and-experienced-happiness-in-columbus-ohio-and-rennes-france-11371/

Kahneman, D., & Riis, J. (2005). *Living, and thinking about it: Two perspectives on life* (F. A. Huppert, N. Baylis, & B. Keverne, Eds.; pp. 284–305). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198567523.003.0011

Karg, K., Burmeister, M., Shedden, K., & Sen, S. (2011). The Serotonin Transporter Promoter Variant (5-HTTLPR), Stress, and Depression Meta-Analysis Revisited: Evidence of Genetic Moderation. *Archives of General Psychiatry*, *68*(5), 444–454. https://doi.org/10.1001/archgenpsychiatry.2010.189

Kashima, E. S., Kent, S., & Kashima, Y. (2015). Life satisfaction in the new country: A multilevel longitudinal analysis of effects of culture and 5-HTT allele frequency distribution in country of origin. *Social Cognitive and Affective Neuroscience*, *10*(1), 50–54. https://doi.org/10.1093/scan/nsu036

Keller, M. C., Coventry, W. L., Heath, A. C., & Martin, N. G. (2005). Widespread Evidence for Non-Additive Genetic Variation in Cloninger's and Eysenck's Personality Dimensions using a Twin Plus Sibling Design. *Behavior Genetics*, *35*(6), 707–721. https://doi.org/10.1007/s10519-005-6041-7

Keyes, C. L. M., Myers, J. M., & Kendler, K. S. (2010). The Structure of the Genetic and Environmental Influences on Mental Well-Being. *American Journal of Public Health*, *100*(12), 2379–2384. https://doi.org/10.2105/AJPH.2010.193615

Killingsworth, M. A. (2021). Experienced well-being rises with income, even above $75,000 per year. *Proceedings of the National Academy of Sciences*, *118*(4), e2016976118. https://doi.org/10.1073/pnas.2016976118

Kim, D., Kubzansky, L. D., Baccarelli, A., Sparrow, D., Spiro, A., Tarantini, L., Cantone, L., Vokonas, P., & Schwartz, J. (2016). Psychological factors and DNA methylation of genes related to immune/inflammatory system markers: The VA Normative Aging Study. *BMJ Open*, *6*(1), e009790. https://doi.org/10.1136/bmjopen-2015-009790

Kim, E. S., DELANEY, S. W., TAY, L., CHEN, Y., DIENER, E., & VANDERWEELE, T. J. (2021). Life Satisfaction and Subsequent Physical, Behavioral, and Psychosocial Health in Older Adults. *The Milbank Quarterly*, *99*(1), 209–239. https://doi.org/10.1111/1468-0009.12497

Kim, E. S., Park, N., Sun, J. K., Smith, J., & Peterson, C. (2014). Life Satisfaction and Frequency of Doctor Visits. *Psychosomatic Medicine*, *76*(1), 86. https://doi.org/10.1097/PSY.0000000000000024

Koivumaa-Honkanen, H., Honkanen, R., Viinamäki, H., Heikkilä, K., Kaprio, J., & Koskenvuo, M. (2000). Self-reported life satisfaction and 20-year mortality in healthy Finnish adults. *American Journal of Epidemiology*, *152*(10), 983–991. https://doi.org/10.1093/aje/152.10.983

Koivumaa-Honkanen, H., Honkanen, R., Viinamäki, H., Heikkilä, K., Kaprio, J., & Koskenvuo, M. (2001). Life Satisfaction and Suicide: A 20-Year Follow-Up Study. *American Journal of Psychiatry*, *158*(3), 433–439. https://doi.org/10.1176/appi.ajp.158.3.433

Koivumaa-Honkanen, H., Kaprio, J., Honkanen, R. J., Viinamäki, H., & Koskenvuo, M. (2005). The stability of life satisfaction in a 15-year follow-up of adult Finns healthy at baseline. *BMC Psychiatry*, *5*, 4. https://doi.org/10.1186/1471-244X-5-4

Koivumaa-Honkanen, H., Kaprio, J., Honkanen, R., Viinamäki, H., & Koskenvuo, M. (2004). Life satisfaction and depression in a 15-year follow-up of healthy adults. *Social Psychiatry and Psychiatric Epidemiology*, *39*(12), 994–999. https://doi.org/10.1007/s00127-004-0833-6

Koivumaa-Honkanen, H., Rissanen, T., Hintikka, J., Honkalampi, K., Haatainen, K., Tarja, S., & Viinamäki, H. (2011). Factors associated with life satisfaction in a 6-year follow-up of depressive out-patients. *Social Psychiatry and Psychiatric Epidemiology*, *46*(7), 595–605. https://doi.org/10.1007/s00127-010-0225-z

Konkolÿ Thege, B., Littvay, L., Tarnoki, D. L., & Tarnoki, A. D. (2017). Genetic and Environmental Effects on Eudaimonic and Hedonic Well-Being: Evidence from a Post-Communist Culture. *Current Psychology*, *36*(1), 84–89. https://doi.org/10.1007/s12144-015-9387-x

Kuepper, Y., Wielpuetz, C., Alexander, N., Mueller, E., Grant, P., & Hennig, J. (2012). 5-HTTLPR S-allele: A genetic plasticity factor regarding the effects of life events on personality? *Genes, Brain and Behavior*, *11*(6), 643–650. https://doi.org/10.1111/j.1601-183X.2012.00783.x

Kuhn, L., Noack, H., Skoluda, N., Wagels, L., Röhr, A.-K., Schulte, C., Eisenkolb, S., Nieratschker, V., Derntl, B., & Habel, U. (2021). The association of the 5-HTTLPR polymorphism and the response to different stressors in healthy males. *Journal of Neural Transmission*, *128*(9), 1347–1359. https://doi.org/10.1007/s00702-021-02390-4

Lachmann, B., Doebler, A., Sindermann, C., Sariyska, R., Cooper, A., Haas, H., & Montag, C. (2021). The Molecular Genetics of Life Satisfaction: Extending Findings from a Recent Genome-Wide Association Study and Examining the Role of the Serotonin Transporter. *Journal of Happiness Studies*, *22*(1), 305–322. https://doi.org/10.1007/s10902-020-00231-x

Lanktree, M. B., & Hegele, R. A. (2018). Metabolic Syndrome. In *Genomic and Precision Medicine* (pp. 47–63). Elsevier. https://doi.org/10.1016/B978-0-12-801812-5.00015-9

Layard, R. (2010). *Measuring Subjective Well-Being*.
Lim, C., & Putnam, R. D. (2010). Religion, Social Networks, and Life Satisfaction. *American Sociological Review*, *75*(6), 914–933.

Lombardo, P., Jones, W., Wang, L., Shen, X., & Goldner, E. M. (2018). The fundamental association between mental health and life satisfaction: Results from successive waves of a Canadian national survey. *BMC Public Health*, *18*(1), 342. https://doi.org/10.1186/s12889-018-5235-x

López-Ortega, M., Torres-Castro, S., & Rosas-Carrasco, O. (2016). Psychometric properties of the Satisfaction with Life Scale (SWLS): Secondary analysis of the Mexican Health and Aging Study. *Health and Quality of Life Outcomes*, *14*(1), 170. https://doi.org/10.1186/s12955-016-0573-9

Lucas, R. E. (2007). Adaptation and the Set-Point Model of Subjective Well-Being: Does Happiness Change After Major Life Events? *Current Directions in Psychological Science*, *16*(2), 75–79. https://doi.org/10.1111/j.1467-8721.2007.00479.x

Lucas, R. E., Clark, A. E., Georgellis, Y., & Diener, E. (2003). Reexamining adaptation and the set point model of happiness: Reactions to changes in marital status. *Journal of Personality and Social Psychology*, *84*(3), 527–539. https://doi.org/10.1037/0022-3514.84.3.527

Lucas, R. E., & Lawless, N. M. (2013). Does Life Seem Better on a Sunny Day? Examining the Association between Daily Weather Conditions and Life Satisfaction Judgments. *Journal of Personality and Social Psychology*, *104*(5), 872–884. https://doi.org/10.1037/a0032124

Luhmann, M., & Eid, M. (2009). Does it really feel the same? Changes in life satisfaction following repeated life events. *Journal of Personality and Social Psychology*, *97*(2), 363. https://doi.org/10.1037/a0015809

Luhmann, M., Hofmann, W., Eid, M., & Lucas, R. E. (2012). Subjective Well-Being and Adaptation to Life Events: A Meta-Analysis on Differences Between Cognitive and Affective Well-Being. *Journal of Personality and Social Psychology*, *102*(3), 592–615. https://doi.org/10.1037/a0025948

Lykken, D., & Tellegen, A. (1996). Happiness Is a Stochastic Phenomenon. *Psychological Science*, *7*(3), 186–189. https://doi.org/10.1111/j.1467-9280.1996.tb00355.x

Lysberg, F., Bjerregaard Bertelsen, T., Lysberg, C., Høie, M., Espnes, G. A., & Innstrand, S. T. (2021). Change and stability: Within-person life satisfaction over a 20-year period using data from the HUNT survey. *Scandinavian Journal of Public Health*, *49*(8), 851–856. https://doi.org/10.1177/1403494820957439

Maddux, J. E. (2008). Positive Psychology and the Illness Ideology: Toward a Positive Clinical Psychology. *Applied Psychology*, *57*(s1), 54–70. https://doi.org/10.1111/j.1464-0597.2008.00354.x

Malvaso, A., & Kang, W. (2022). The relationship between areas of life satisfaction, personality, and overall life satisfaction: An integrated account. *Frontiers in Psychology*, *13*, 894610. https://doi.org/10.3389/fpsyg.2022.894610

Matsunaga, M., Isowa, T., Yamakawa, K., & Ohira, H. (2013). Association between the serotonin transporter polymorphism (5HTTLPR) and subjective happiness level in Japanese adults. *Psychology of Well-Being: Theory, Research and Practice*, *3*(1), 5. https://doi.org/10.1186/2211-1522-3-5

Michalski, C. A., Diemert, L. M., Hurst, M., Goel, V., & Rosella, L. C. (2022). Is life satisfaction associated with future mental health service use? An observational population-based cohort study. *BMJ Open*, *12*(4), e050057. https://doi.org/10.1136/bmjopen-2021-050057

Miller, D. N. (2011). Life Satisfaction. In S. Goldstein & J. A. Naglieri (Eds.), *Encyclopedia of Child Behavior and Development* (pp. 887–889). Springer US. https://doi.org/10.1007/978-0-387-79061-9_1659

Miller, R., Wankerl, M., Stalder, T., Kirschbaum, C., & Alexander, N. (2013). The serotonin transporter gene-linked polymorphic region (5-HTTLPR) and cortisol stress reactivity: A meta-analysis. *Molecular Psychiatry*, *18*(9), Article 9. https://doi.org/10.1038/mp.2012.124

Mõttus, R., Realo, A., Allik, J., Ausmees, L., Henry, S., McCrae, R. R., & Vainik, U. (2024). Most people's life satisfaction matches their personality traits: True correlations in multitrait, multirater, multisample data. *Journal of Personality and Social Psychology*, *126*(4), 676–693. https://doi.org/10.1037/pspp0000501

Neale, M. C., & Maes, H. H. M. (2004). *Methodology for Genetic Studies of Twins and Families*.

Nes. (2015). *Genetics of Psychological Well-being: The Role of Heritability and Genetics in Positive Psychology*. Oxford University Press.
Nes, R. B. (2009). Happiness in Behaviour Genetics: Findings and Implications. *Journal of Happiness Studies*, *11*(3), 369–381. https://doi.org/10.1007/s10902-009-9145-6

Nes, R. B., Czajkowski, N. O., Røysamb, E., Ørstavik, R. E., Tambs, K., & Reichborn-Kjennerud, T. (2013). Major Depression and Life satisfaction: A population-based twin study. *Journal of Affective Disorders*, *144*(1–2), 51–58. https://doi.org/10.1016/j.jad.2012.05.060

Nes, R. B., Czajkowski, N., R∅ysamb, E., Reichborn-Kjennerud, T., & Tambs, K. (2008). Well-being and ill-being: Shared environments, shared genes? *The Journal of Positive Psychology*, *3*(4), 253–265. https://doi.org/10.1080/17439760802399323

Nes, R. B., Czajkowski, N., & Tambs, K. (2010). Family Matters: Happiness in Nuclear Families and Twins. *Behavior Genetics*, *40*(5), 577–590. https://doi.org/10.1007/s10519-010-9365-x

Nes, R. B., & Røysamb, E. (2015). The heritability of subjective well-being: Review and meta-analysis. In M. Pluess (Ed.), *Genetics of Psychological Well-Being: The role of heritability and genetics in positive psychology* (p. 0). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199686674.003.0005

Nes, R. B., & Røysamb, E. (2016). Happiness in Behaviour Genetics: An Update on Heritability and Changeability. *Journal of Happiness Studies*, *18*(5), 1533–1552. https://doi.org/10.1007/s10902-016-9781-6

Nes, R. B., Røysamb, E., Harris, J. R., Czajkowski, N., & Tambs, K. (2010). Mates and marriage matter: Genetic and environmental influences on subjective wellbeing across marital status. *Twin Research and Human Genetics: The Official Journal of the International Society for Twin Studies*, *13*(4), 312–321. https://doi.org/10.1375/twin.13.4.312

Nes, R., Røysamb, E., Tambs, K., Harris, J., & Reichborn-Kjennerud, T. (2006). Subjective well-being: Genetic and environmental contributions to stability and change. *Psychological Medicine*, *36*, 1033–1042. https://doi.org/10.1017/S0033291706007409

Ng, H. K. Y., Chen, S. X., & Lam, B. C. P. (2024). Does Religious Worldview Benefit Life Satisfaction? Examination of the Incremental Predictive Power, Underlying Mechanism, and Temporal Relationship in Hong Kong and the USA. *Journal of Religion and Health*, *63*(4), 2877–2894. https://doi.org/10.1007/s10943-023-01934-0

Ng, S. T., Tey, N. P., & Asadullah, M. N. (2017). What matters for life satisfaction among the oldest-old? Evidence from China. *PLOS ONE*, *12*(2), e0171799. https://doi.org/10.1371/journal.pone.0171799

Ngamaba, K. H., Panagioti, M., & Armitage, C. J. (2017). How strongly related are health status and subjective well-being? Systematic review and meta-analysis. *European Journal of Public Health*, *27*(5), 879–885. https://doi.org/10.1093/eurpub/ckx081

Ngamaba, K. H., & Soni, D. (2018). Are Happiness and Life Satisfaction Different Across Religious Groups? Exploring Determinants of Happiness and Life Satisfaction. *Journal of Religion and Health*, *57*(6), 2118–2139. https://doi.org/10.1007/s10943-017-0481-2

OECD. (2020). *How's Life? 2020: Measuring Well-being*. OECD. https://doi.org/10.1787/9870c393-en

Oh, E.-A., & Bae, S.-M. (2023). The relationship between personality, social capital, and life satisfaction of elderly Koreans. *Psychogeriatrics: The Official Journal of the Japanese Psychogeriatric Society*, *23*(3), 494–502. https://doi.org/10.1111/psyg.12960

Ohtsubo, Y., Matsunaga, M., Masuda, T., Noguchi, Y., Yamasue, H., & Ishii, K. (2022). Test of the Serotonin Transporter Gene × Early Life Stress Interaction Effect on Subjective Well-Being

and Loneliness Among Japanese Young Adults. *Japanese Psychological Research*, *64*(2), 193–204. https://doi.org/10.1111/jpr.12376

Oishi, S., Diener, E. F., Lucas, R. E., & Suh, E. M. (1999). Cross-Cultural Variations in Predictors of Life Satisfaction: Perspectives from Needs and Values. *Personality and Social Psychology Bulletin*, *25*(8), 980–990. https://doi.org/10.1177/01461672992511006

Okbay, A., Baselmans, B. M. L., De Neve, J.-E., Turley, P., Nivard, M. G., Fontana, M. A., Meddens, S. F. W., Linnér, R. K., Rietveld, C. A., Derringer, J., Gratten, J., Lee, J. J., Liu, J. Z., de Vlaming, R., Ahluwalia, T. S., Buchwald, J., Cavadino, A., Frazier-Wood, A. C., Davies, G., … Cesarini, D. (2016). Genetic variants associated with subjective well-being, depressive symptoms and neuroticism identified through genome-wide analyses. *Nature Genetics*, *48*(6), 624–633. https://doi.org/10.1038/ng.3552

Olaru, G., van Scheppingen, M. A., Bleidorn, W., & Denissen, J. J. A. (2023). The link between personality, global, and domain-specific satisfaction across the adult lifespan. *Journal of Personality and Social Psychology*, *125*(3), 590–606. https://doi.org/10.1037/pspp0000461

Olson, J., Martin, R. L., & Connell, N. M. (2021). Satisfaction with life and crime: Testing the link. *Psychology, Crime & Law*, *27*(7), 631–655. https://doi.org/10.1080/1068316X.2020.1849692

Ong, A. D., Benson, L., Zautra, A., & Ram, N. (2018). Emodiversity and Biomarkers of Inflammation. *Emotion (Washington, D.C.)*, *18*(1), 3–14. https://doi.org/10.1037/emo0000343

Ortiz-Ospina, E., & Roser, M. (2023). Happiness and Life Satisfaction. *Our World in Data*. https://ourworldindata.org/happiness-and-life-satisfaction

Oswald, A. J., Proto, E., & Sgroi, D. (2015). Happiness and Productivity. *Journal of Labor Economics*, *33*(4), 789–822. https://doi.org/10.1086/681096

Paunio, T., Korhonen, T., Hublin, C., Partinen, M., Kivimäki, M., Koskenvuo, M., & Kaprio, J. (2009). Longitudinal study on poor sleep and life dissatisfaction in a nationwide cohort of twins. *American Journal of Epidemiology*, *169*(2), 206–213. https://doi.org/10.1093/aje/kwn305

Pelt, D. H. M., Schwabe, I., & Bartels, M. (2023). Bias in Gene-by-Environment Interaction Effects with Sum Scores; An Application to Well-being Phenotypes. *Behavior Genetics*. https://doi.org/10.1007/s10519-023-10137-y

Plomin, R., Scheier, M. F., Bergeman, C. S., Pedersen, N. L., Nesselroade, J. R., & McClearn, G. E. (1992). Optimism, pessimism and mental health: A twin/adoption analysis. *Personality and Individual Differences*, *13*(8), 921–930. https://doi.org/10.1016/0191-8869(92)90009-E

Pluess, M., Belsky, J., Way, B. M., & Taylor, S. E. (2010). 5-HTTLPR Moderates Effects of Current Life Events on Neuroticism: Differential Susceptibility to Environmental Influences. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, *34*(6), 1070–1074. https://doi.org/10.1016/j.pnpbp.2010.05.028

Posthuma, D., & Boomsma, D. !. (2000). *A note on the statistical power in extended twin studies.* https://psycnet.apa.org/record/2000-05706-008

Proto, E., & Rustichini, A. (2013). A Reassessment of the Relationship between GDP and Life Satisfaction. *PLoS ONE*, *8*(11), e79358. https://doi.org/10.1371/journal.pone.0079358

Purcell, S. (2002). Variance components models for gene-environment interaction in twin analysis. *Twin Research: The Official Journal of the International Society for Twin Studies*, *5*(6), 554–571. https://doi.org/10.1375/136905202762342026

Ren, Z., Yue, G., Xiao, W., & Fan, Q. (2022). The Influence of Subjective Socioeconomic Status on Life Satisfaction: The Chain Mediating Role of Social Equity and Social Trust. *International Journal of Environmental Research and Public Health*, *19*(23), 15652. https://doi.org/10.3390/ijerph192315652

Rietveld, C. A., Cesarini, D., Benjamin, D. J., Koellinger, P. D., De Neve, J.-E., Tiemeier, H., Johannesson, M., Magnusson, P. K. E., Pedersen, N. L., Krueger, R. F., & Bartels, M. (2013). Molecular genetics and subjective well-being. *Proceedings of the National Academy of Sciences*, *110*(24), 9692–9697. https://doi.org/10.1073/pnas.1222171110

Røysamb, E., Harris, J. R., Magnus, P., Vittersø, J., & Tambs, K. (2002). Subjective well-being. Sex-specific effects of genetic and environmental factors. *Personality and Individual Differences*, *32*(2), 211–223. https://doi.org/10.1016/S0191-8869(01)00019-8

Røysamb, E., Moffitt, T. E., Caspi, A., Ystrøm, E., & Nes, R. B. (2023). Worldwide Well-Being: Simulated Twins Reveal Genetic and (Hidden) Environmental Influences. *Perspectives on Psychological Science*, 17456916231178716. https://doi.org/10.1177/17456916231178716

Røysamb, E., & Nes, R. (2018). *The Genetics of Well-being*.

Røysamb, E., Nes, R. B., Czajkowski, N. O., & Vassend, O. (2018). Genetics, personality and wellbeing. A twin study of traits, facets and life satisfaction. *Scientific Reports*, *8*, 12298. https://doi.org/10.1038/s41598-018-29881-x

Røysamb, E., Tambs, K., Reichborn-Kjennerud, T., Neale, M., & Harris, J. (2003). Happiness and Health: Environmental and Genetic Contributions to the Relationship Between Subjective Well-Being, Perceived Health, and Somatic Illness. *Journal of Personality and Social Psychology*, *85*, 1136–1146. https://doi.org/10.1037/0022-3514.85.6.1136

Rutter, M., Thapar, A., & Pickles, A. (2009). Gene-Environment Interactions: Biologically Valid Pathway or Artifact? *Archives of General Psychiatry*, *66*(12), 1287–1289. https://doi.org/10.1001/archgenpsychiatry.2009.167

Sander, W. (2017). Religion, Religiosity, and Happiness. *Review of Religious Research*, *59*(2), 251–262.

Sauce, B., & Matzel, L. D. (2018). The Paradox of Intelligence: Heritability and Malleability Coexist in Hidden Gene-Environment Interplay. *Psychological Bulletin*, *144*(1), 26–47. https://doi.org/10.1037/bul0000131

Saunders, G. R. B., Elkins, I. J., Christensen, K., & McGue, M. (2018). The Relationship Between Subjective Wellbeing and Mortality within Discordant Twin Pairs from Two Independent Samples. *Psychology and Aging*, *33*(3), 439–447. https://doi.org/10.1037/pag0000248

Schellekens, J. J., & Okun, B. S. (2024). Religiosity and Overall Life Satisfaction: Muslim Arabs in Israel. *Journal of Religion and Health*, *63*(4), 2490–2500. https://doi.org/10.1007/s10943-023-01937-x

Schimmack, U., & Oishi, S. (2005). The influence of chronically and temporarily accessible information on life satisfaction judgments. *Journal of Personality and Social Psychology*, *89*(3), 395–406. https://doi.org/10.1037/0022-3514.89.3.395

Schimmack, U., Oishi, S., Furr, R. M., & Funder, D. C. (2004). Personality and Life Satisfaction: A Facet-Level Analysis. *Personality and Social Psychology Bulletin*, *30*(8), 1062–1075. https://doi.org/10.1177/0146167204264292

Seligman, M., & Csikszentmihalyi, M. (2000). Positive Psychology: An Introduction. *The American Psychologist*, *55*, 5–14. https://doi.org/10.1037/0003-066X.55.1.5

Seligman, M. E. P., & Csikszentmihalyi, M. (2014). Positive Psychology: An Introduction. In M. Csikszentmihalyi (Ed.), *Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi* (pp. 279–298). Springer Netherlands. https://doi.org/10.1007/978-94-017-9088-8_18

Shin, D. C., & Johnson, D. M. (1978). Avowed happiness as an overall assessment of the quality of life. *Social Indicators Research*, *5*(1), 475–492. https://doi.org/10.1007/BF00352944

Siedlecki, K. L., Salthouse, T. A., Oishi, S., & Jeswani, S. (2014). The Relationship Between Social Support and Subjective Well-Being Across Age. *Social Indicators Research*, *117*(2), 561–576. https://doi.org/10.1007/s11205-013-0361-4

Song, L., Meng, J., Liu, Q., Huo, T., Zhu, X., Li, Y., Ren, Z., Wang, X., & Qiu, J. (2019). Polygenic Score of Subjective Well-Being Is Associated with the Brain Morphology in Superior Temporal Gyrus and Insula. *Neuroscience*, *414*, 210–218. https://doi.org/10.1016/j.neuroscience.2019.05.055

Steel, P., Schmidt, J., & Shultz, J. (2008). Refining the relationship between personality and subjective well-being. *Psychological Bulletin*, *134*(1), 138–161. https://doi.org/10.1037/0033-2909.134.1.138

Stenlund, S. (2022). *Bidirectional Relationship Between Health Behavior and Subjective Well-Being in Adults*.

Stenlund, S., Junttila, N., Koivumaa-Honkanen, H., Sillanmäki, L., Stenlund, D., Suominen, S., Lagström, H., & Rautava, P. (2021). Longitudinal stability and interrelations between health behavior and subjective well-being in a follow-up of nine years. *PLoS ONE*, *16*(10), e0259280. https://doi.org/10.1371/journal.pone.0259280

Stenlund, S., Koivumaa-Honkanen, H., Sillanmäki, L., Lagström, H., Rautava, P., & Suominen, S. (2021). Subjective well-being predicts health behavior in a population-based 9-years follow-up of working-aged Finns. *Preventive Medicine Reports*, *24*, 101635. https://doi.org/10.1016/j.pmedr.2021.101635

Steptoe, A., O'Donnell, K., Badrick, E., Kumari, M., & Marmot, M. (2008). Neuroendocrine and Inflammatory Factors Associated with Positive Affect in Healthy Men and Women: The Whitehall II Study. *American Journal of Epidemiology*, *167*(1), 96–102. https://doi.org/10.1093/aje/kwm252

Strine, T. W., Chapman, D. P., Balluz, L. S., Moriarty, D. G., & Mokdad, A. H. (2008). The Associations Between Life Satisfaction and Health-related Quality of Life, Chronic Illness, and Health Behaviors among U.S. Community-dwelling Adults. *Journal of Community Health*, *33*(1), 40–50. https://doi.org/10.1007/s10900-007-9066-4

Stubbe, J. H., Posthuma, D., Boomsma, D. I., & De Geus, E. J. C. (2005). Heritability of life satisfaction in adults: A twin-family study. *Psychological Medicine*, *35*(11), 1581–1588. https://doi.org/10.1017/S0033291705005374

Tan, C.-Y., Chuah, C.-Q., Lee, S.-T., & Tan, C.-S. (2021). Being Creative Makes You Happier: The Positive Effect of Creativity on Subjective Well-Being. *International Journal of Environmental Research and Public Health*, *18*(14), 7244. https://doi.org/10.3390/ijerph18147244

Tay, L., & Diener, E. (2011). *Needs and subjective well-being around the world—PubMed*. https://pubmed.ncbi.nlm.nih.gov/21688922/

Tay, L., Herian, M. N., & Diener, E. (2014). Detrimental Effects of Corruption and Subjective Well-Being: Whether, How, and When. *Social Psychological and Personality Science*, *5*(7), 751–759. https://doi.org/10.1177/1948550614528544

The Global Happiness Council (2022). Global Happiness and Well-being Policy Report 2022. New York: Sustainable Development Solutions Network

Van ‘t Ent, D., den Braber, A., Baselmans, B. M. L., Brouwer, R. M., Dolan, C. V., Hulshoff Pol, H. E., de Geus, E. J. C., & Bartels, M. (2017). Associations between subjective well-being and subcortical brain volumes. *Scientific Reports*, *7*(1), Article 1. https://doi.org/10.1038/s41598-017-07120-z

Veenhoven, R. (1996). *THE STUDY OF LIFE SATISFACTION*.

Vukasović, T., & Bratko, D. (2015). Heritability of personality: A meta-analysis of behavior genetic studies. *Psychological Bulletin*, *141*(4), 769–785. https://doi.org/10.1037/bul0000017

Wang, R. A. H., Davis, O. S. P., Wootton, R. E., Mottershaw, A., & Haworth, C. M. A. (2017). Social support and mental health in late adolescence are correlated for genetic, as well as environmental, reasons. *Scientific Reports*, *7*(1), Article 1. https://doi.org/10.1038/s41598-017-13449-2

Warmerdam, C. A. R., Wiersma, H. H., Lanting, P., Ani, A., Initiative, L. C. R., Study, L. C., Dijkema, M. X. L., Snieder, H., Vonk, J. M., Boezen, H. M., Deelen, P., & Franke, L. H. (2022). Increased genetic contribution to wellbeing during the COVID-19 pandemic. *PLoS Genetics*, *18*(5). https://doi.org/10.1371/journal.pgen.1010135

Weiss, A., Baselmans, B. M. L., Hofer, E., Yang, J., Okbay, A., Lind, P. A., Miller, M. B., Nolte, I. M., Zhao, W., Hagenaars, S. P., Hottenga, J.-J., Matteson, L. K., Snieder, H., Faul, J. D., Hartman, C. A., Boyle, P. A., Tiemeier, H., Mosing, M. A., Pattie, A., … Luciano, M. (2016). Personality Polygenes, Positive Affect, and Life Satisfaction. *Twin Research and Human Genetics : The Official Journal of the International Society for Twin Studies*, *19*(5), 407–417. https://doi.org/10.1017/thg.2016.65

Weiss, A., Bates, T. C., & Luciano, M. (2008). Happiness is a personal(ity) thing: The genetics of personality and well-being in a representative sample. *Psychological Science*, *19*(3), 205–210. https://doi.org/10.1111/j.1467-9280.2008.02068.x

Whisman, M. A., Rhee, S. H., Hink, L., Boeldt, D. L., & Johnson, D. P. (2014). Genetic and Environmental Influences on the Association between Subjective Well-Being and Marital Adjustment. *Couple & Family Psychology*, *3*(1), 48–64. https://doi.org/10.1037/cfp0000008

Wootton, R. E., Davis, O. S. P., Mottershaw, A. L., Wang, R. A. H., & Haworth, C. M. A. (2017). Genetic and environmental correlations between subjective wellbeing and experience of

life events in adolescence. *European Child & Adolescent Psychiatry*, *26*(9), 1119–1127. https://doi.org/10.1007/s00787-017-0997-8

World Health Organization. Regional Office for Europe. (2018). Targets and indicators for Health 2020: version 4. World Health Organization. Regional Office for Europe. https://iris.who.int/handle/10665/345565

Xu, J., & Roberts, R. E. (2010). The power of positive emotions: It's a matter of life or death—Subjective well-being and longevity over 28 years in a general population. *Health Psychology*, *29*(1), 9–19. https://doi.org/10.1037/a0016767

Yap, S. C. Y., Wortman, J., Anusic, I., Baker, S. G., Scherer, L. D., Donnellan, M. B., & Lucas, R. E. (2017). The Effect of Mood on Judgments of Subjective Well-Being: Nine Tests of the Judgment Model. *Journal of Personality and Social Psychology*, *113*(6), 939–961. https://doi.org/10.1037/pspp0000115

Zilioli, S., Imami, L., & Slatcher, R. B. (2015). Life satisfaction moderates the impact of socioeconomic status on diurnal cortisol slope. *Psychoneuroendocrinology*, *60*, 91–95. https://doi.org/10.1016/j.psyneuen.2015.06.010

Zotti, R., Speziale, N., & Barra, C. (2016). On the causal effect of religiosity on life satisfaction using a propensity score matching technique. *International Journal of Social Economics*, *43*(10), 1031–1048. https://doi.org/10.1108/IJSE-12-2014-0262

Zullig, K. J., Valois, R. F., Huebner, E. S., & Drane, J. W. (2005). Adolescent health-related quality of life and perceived satisfaction with life. *Quality of Life Research*, *14*(6), 1573–1584. https://doi.org/10.1007/s11136-004-7707-y

Zullig, K. J., Valois, R. F., Huebner, E. S., Oeltmann, J. E., & Drane, J. W. (2001). Relationship between perceived life satisfaction and adolescents' substance abuse. *Journal of Adolescent Health*, *29*(4), 279–288. https://doi.org/10.1016/S1054-139X(01)00269-5

Zwir, I., Arnedo, J., Del-Val, C., Pulkki-Råback, L., Konte, B., Yang, S. S., Romero-Zaliz, R., Hintsanen, M., Cloninger, K. M., Garcia, D., Svrakic, D. M., Rozsa, S., Martinez, M., Lyytikäinen, L.-P., Giegling, I., Kähönen, M., Hernandez-Cuervo, H., Seppälä, I., Raitoharju, E., … Cloninger, C. R. (2020). Uncovering the complex genetics of human character. *Molecular Psychiatry*, *25*(10), Article 10. https://doi.org/10.1038/s41380-018-0263-6