Biological Underpinnings of Positive Emotions and Purpose

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Chapter to appear in J. Forgas & R. Baumeister (Eds). *The Social Psychology of the Good Life*. New York: Psychology Press.

Draft date: December 22, 2016

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A good life, arguably, is one that includes being healthy and living long. A host of social psychological constructs have been related to physical health and longevity, among them positive emotions and purpose (e.g., Chida & Steptoe, 2008; Hill & Turiano, 2014). These two constructs are also positively correlated (Keyes, Shmotkin, & Ryff, 2002; Waterman, 1993). Whereas some scholars take this positive association to indicate that positive emotions and purpose are fundamentally confounded (Brown, MacDonald, Samanta, Friedman, & Coyne, 2014; Coyne, 2013), I see them as distinct and interacting in complex and dynamic ways. Positive emotions, for instance, have been found to prospectively predict and cause increases in purpose, as indicated by the likelihood of detecting meaning in life (Hicks, Schlegel, & King, 2010; Hicks, Trent, Davis, & King, 2012; King & Hicks, 2009; King, Hicks, Krull, & Del Gaiso, 2006). In addition, studies have shown that purpose-laden experiences and activities, such spirituality and meditation, predict and cause increases in positive emotions (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Van Cappellen, Way, Isgett, & Fredrickson, 2016). Reciprocal causality can thus be expected here, such that positive emotions and purpose augment and are augmented by each other in an upward spiral dynamic. Moreover, positive emotions and purpose are not merely subjective experiences. Each appears also to shape and be shaped by an individual's biological attributes, be it their genes, their gene expression, their cardiovascular functioning, or their oxytocin levels. This chapter explores these various biological underpinnings of positive emotions and purpose. But first, let's agree on terminology.

Positive emotions, as the term is used here, include a range of discernable pleasant affective states, including joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe, and love. This list is not exhaustive. Rather it covers a set of positive emotions that research suggests people experience with some frequency in daily life (Fredrickson, 2013). Like all emotions, positive emotions are brief, multisystem activation patterns related to changes in the way people make sense of their current circumstances. When these multi-system activation patterns register that an individual's circumstances are somehow bad for the self, an unpleasant affective state is experienced; when it registers good prospects or good fortune, a pleasant affective state is experienced. The particulars of an individual's past experiences and current situation ultimately shape the emotion(s) that will be experienced. Despite the wide range of positive emotions, at times this construct is measured as a single dimension of positive affect or hedonia.

Purpose, as characterized here, also includes a range of discernable psychological constructs. Holding these constructs together is the shared feature of transcending immediate self-gratification – be it sensory, emotional, or material – to connect the self to something larger. Defined as such, purpose includes experiences of meaning, spirituality, or a calling, or feeling connected and "in tune" with others or with nature. It also includes eudaimonia, a term at times used to rope these various transcendent experiences together (see Vittersø, in press). For the present chapter, however, I use the term "purpose" as an umbrella term to encompass these various forms of self-transcendence, for both its accessibility and its alliteration with positive emotions.

The *broaden-and-build theory* (Fredrickson, 1998, 2013) provides a theoretical backdrop for the present exploration of the biological underpinnings of positive emotions and purpose. In brief, the broaden-and-build theory posits that various positive emotions momentarily broaden people's awareness in ways that, over time, incrementally build their resources and resilience. Ample empirical evidence now supports this theory (for a review, see Fredrickson, 2013). As just one example, longitudinal randomized controlled trials (Fredrickson et al., 2008; Kok et al., 2013) have demonstrated that an intervention that helps people to subtly increase their day-to-day positive emotions – based on the purpose-laden practice of meditation – in turn builds people's resources. These increased resources are wide-ranging, including those that are social (e.g., feeling connected to others; Fredrickson et al., 2008; Kok et al., 2013), psychological (e.g., purpose in life, mindfulness; Fredrickson et al., 2008) and biological (e.g., cardiac vagal tone; Kok et al., 2013).

Greater resources, in turn, predict greater emotional well-being (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Fredrickson et al., 2008), in part through upward spiral dynamics (Fredrickson & Cohn, 2008). My team and I have identified a subset of the resources built through experiences of positive emotions as potentially potent in promoting good lives. Following Pluess and Belsky (2013), we call these *vantage resources* to the extent that they render people more sensitive to subsequent positive experiences (Van Cappellen, Rice, Catalino, & Fredrickson, 2016). That is, just as malleable risk factors (e.g., pessimism, inflammation) can deter health and wellbeing by altering affective processes, malleable vantage resources (e.g., purpose in life, cardiac vagal tone) can support health and wellbeing by amplifying (moderating) positive emotions experienced in day-to-day living, creating an upward spiral dynamic. Such recursive, upward spiral processes offer a systems-level perspective on the dynamic and reciprocal causality among affective, social psychological, and biological constructs.

To sum, positive emotions and purpose, theory and evidence suggest, are not merely facets of good lives, but rather they function as active ingredients that help to build even better lives. The following three sections focus in turn on three distinct biological vantage resources that may – through such dynamic processes – underpin people's experiences of positive emotions and purpose.

Leukocyte Gene Expression

The close association between positive emotions and purpose has made it a challenge to discern which is more directly associated with biological health benefits. To unravel this mystery, our team gathered self-reports of positive emotions (assessed as hedonia) and purpose (assessed as eudaimonia; each via the Mental Health Continuum-Short Form, MHC-SF; (Keyes, 2002; Keyes & Annas, 2009; Lamers, Westerhof, Bohlmeijer, ten Klooster, & Keyes, 2011). In addition to these self-report measures, we drew a blood sample from each participant to examine profiles of gene expression within their circulating white blood cells.

This approach to using functional genomics as a window onto physical health status was inspired by the work of my collaborator Steve Cole. Across a series of studies, Cole and his collaborators had linked adverse psychological and social conditions to a pattern of altered gene expression within circulating leukocytes (Cole, 2012, 2013; Irwin & Cole, 2011). This profile, termed the *conserved transcriptional response to adversity* (CTRA), is marked by higher expression of genes involved in inflammation (e.g., pro-inflammatory cytokines such as *IL1B, IL6, IL8*, and *TNF*) and lower expression of genes involved in type I IFN antiviral responses (e.g., *IFI-*, *OAS-*, and *MX-* family genes) and IgG1 antibody synthesis (e.g., *IGJ*; Cole, 2012, 2013; Irwin & Cole, 2011; Slavich & Cole, 2013). Studies of non-human primates show that experimental imposition of threatening or unstable social conditions can causally induce CTRA gene expression (Cole et al., 2012; Tung et al., 2012). The CTRA program is thought to have evolved to help human ancestors' immune systems anticipate and counter changing patterns of microbial threat recurrently associated with changing environmental conditions. These could be increased risk of wound-related bacterial infection associated with experienced threat, social conflict, or isolation, or increased risk of socially-mediated viral infection associated with frequent and positive social contact (Cole, Hawkley, Arevalo, & Cacioppo, 2011; Irwin & Cole, 2011). In modern environments, however, chronic CTRA activation by social or psychological threats may promote inflammation-mediated chronic diseases and impair host resistance to viral infections.

Given that various forms of psychosocial adversity had been convincingly linked with the CTRA profile, together with Cole, our team investigated whether positive emotions and purpose – either singly or in combination – would oppose the CTRA gene expression profile, as represented across a set of 53 genes selected *a priori* based on Cole and colleagues' past results within studies of psychosocial adversity. An opposing leukocyte gene expression profile would be marked by a *lower* expression of proinflammatory genes, coupled with a *higher* expression of antiviral and antibody synthesis genes. Such a molecular signature is arguably supportive of a healthy functioning immune system, although that assumption remains to be tested empirically.

Taking this empirical approach our team has published two empirical reports, based on three studies. Because two of those studies used identical measures, here we discuss the results obtained when pooling their respective datasets (N = 198, as presented in Fredrickson, Grewen, et al., 2015, Discovery and Confirmation Studies combined). Mixed effect linear models predicted participants' CTRA gene expression profiles, as observed within their circulating white blood cells, from their self-reports of positive emotions and purpose. Although correlated, these two subjective measures captured distinct constructs. When both positive emotions and purpose are simultaneously entered as predictor variables (alongside an *a priori* set of demographic and health-related control variables), only purpose emerges as significantly associated with the inverse of the CTRA gene expression profile. The association for positive emotions, in this same analysis, is of the opposite sign (i.e., it shows a *positive* association with the adversity-related gene expression profile), albeit not statistically significant. This inverse association between purpose and the CTRA gene expression profile has also emerged in three additional, independent studies that used different and more robust assessments of purpose (Cole et al., 2015; Fredrickson, Grewen, et al., 2015, Generalization Study; Kitayama, Akutsu, Uchida, & Cole, 2016). Together, this accumulating evidence supports the conclusion that purpose may be most directly related to the inverse of the adversity-related pattern of leukocyte gene expression.

This does not necessarily mean that positive emotions play no role in fostering human health and longevity. Indeed, these findings need be interpreted in light of existing evidence that positive emotions prospectively predict and cause increases in purpose, as described above. Even if the elements of positive emotions that are devoid of association with the transcendent experiences of purpose, meaning, contribution, and interconnectedness function as "empty calories" with respect to physical health, the overall construct of positive emotions may be a vital contributing factor to the subsequent detection of meaning and the emergence of purpose. If so, positive emotions may well contribute *indirectly* to a healthy pattern of gene expression as a result of its direct relationship with purpose.

To test this possibility, our team reanalyzed and extended one of our prior studies (i.e., Fredrickson, Grewen, et al., 2015, Confirmation Study) to test whether positive emotions (assessed by the MHC-SF or by 7 consecutive daily reports of 10 distinct positive emotions, via the modified Differential Emotions Scale [mDES], Fredrickson, 2013) predicted the inverse of the CTRA gene expression profile. It did when either index of positive emotions was the sole predictor of the CTRA profile, it showed a negative (healthy) association with this gene expression profile. Yet further tests suggested that purpose, also as indexed by the MHC-SF, accounted for (mediated) this relationship. That is, to the extent that positive emotions are positively associated with purpose, positive emotions are indirectly related to a (presumably) health-supportive pattern of gene expression – one marked by reduced expression of proinflammatory genes and increased expression of antiviral and antibody synthesis genes (Isgett, Boulton, Cole, & Fredrickson, 2016). It is worth noting that this same indirect path between positive emotions and the inverse of the CTRA profile (mediated by purpose) has also been demonstrated within a nationally representative sample (Cole et al., 2015). Purpose, the data suggest, appears to be one of the many durable resources that positive emotions function to build. Although purpose may be more directly tied to the molecular shifts that support physical health, positive emotions may be the more experience-near springboards that lead to increments in purpose. Positive emotions and purpose, then, are dynamically intertwined and each appears to play a vital role in shaping leukocyte gene expression, a plausible biological underpinning of a good life.

Cardiac Vagal Tone

Another biological resource with which my research team and I have seen positive emotions and purpose interrelate is cardiac vagal tone (Kok & Fredrickson, 2010). Cardiac vagal tone represents the concept of autonomic flexibility, or the body's ability to efficiently respond to challenges and changes. Like muscle tone, higher levels are better than lower levels. Cardiac vagal tone is inferred from heart rate variability, which can be indexed using one of a handful of data reduction techniques, including, among others, respiratory sinus arrhythmia (RSA), which incorporates a measure of respiration frequency, and spectral analysis of heart rate variability at various frequencies, with a high-frequency heart rate variability (HF-HRV; 0.12-0.4 Hz) emerging as a frequent choice among researchers. Although researchers continue to debate which data reduction technique is superior, my research team's approach has become to report results using multiple techniques.

Cardiac vagal tone is compelling biological attribute because it too relates both to physical health and to social psychological individual differences. Within the domains of physical health, individuals with higher levels of cardiac vagal tone have been found to have better regulated cardiovascular systems (Thayer & Lane, 2007) better regulated inflammatory processes (Thayer & Sternberg, 2006) and better regulated blood glucose levels (Carnethon, Golden, Folsom, Haskell, & Liao, 2003). Plus, for those who have life-threatening cardiac events, such as myocardial infarctions, physicians look to indices of cardiac vagal tone to estimate patient prognoses (Bibevski & Dunlap, 2011). Within social psychological domains, individuals with higher levels of cardiac vagal tone are better able to regulate their attention (Suess, Porges, & Plude, 1994), their emotions (Demaree, Robinson, Everhart, & Schmeichel, 2004; Porges, Doussard-Roosevelt, & Maiti, 1994), and perhaps because of these superior regulatory abilities, show better social skills (Fabes, Eisenberg, & Eisenbud, 1993). Cardiac vagal tone, then, is a health marker that also shapes consequential intrapersonal social psychological abilities and skills.

Connecting these various intrapersonal abilities and skills to positive emotions and purpose, my team and I have studied the degree to which cardiac vagal tone relates to individuals' quotidian experiences of connection to others. One investigation, led by Suzannah ("Zan") Isgett, measured the cardiac vagal tone of 73 midlife adults alongside their reports on the last time they had engaged in a variety of common activities (e.g., eating a meal, spending time outdoors, commuting). For each activity, participants reported (a) whether anyone else was present with them; (b) the degree to which they considered that particular activity to be social; and (c) the degree to which they experienced 10 positive emotions during it (again indexed by the mDES; Fredrickson, 2013). The pattern of results suggested two distinct associations between cardiac vagal tone and purpose, here indexed as being in connection with others. The first was that higher levels of cardiac vagal tone were associated with more frequently being in the presence of others, a finding consistent with Porges' (2011) prediction the vagus nerve modulates affiliative behavior. The second was that, to the extent that participants viewed these ordinary activities as social, they were associated with greater intensities of positive emotions, a finding consistent with our hypothesis that cardiac vagal tone amplifies the positive emotion yield of activities that involve social connection (Isgett, Kok, et al., 2016). These data suggest that cardiac vagal tone functions as a biological vantage resource, one that amplifies the positive emotions experienced during moments of social connection.

Approaching these same ideas from another angle, Bethany Kok and I examined how individuals' cardiac vagal tone related to their day-to-day experiences of positive emotions, as well as to social experiences that transcend the self, in which individuals felt closer and more "in tune" with others whom they encountered in the course of their day. We drew on another sample of 73 individuals who, as part of a larger study (described below), provided daily reports of their emotion experiences (again using the mDES; Fredrickson, 2013) and rated how "close" and "in tune" they felt with others with whom they interacted that day (items adapted from the UCLA Loneliness Scale; Russell, 1996). Before and after the nine weeks of daily reporting, we assessed participants' cardiac vagal tone. The data revealed that participants with higher initial levels of cardiac vagal tone were more likely to increase week-by-week in their experiences of positive emotions and perceived social connectedness, which here served as our index of self-transcendence or purpose. In addition, those who showed greater increases in positive emotions and purpose were more likely to exhibit increases over the nine weeks in their cardiac vagal tone, a pattern consistent with an upward spiral dynamic of reciprocal causality (Kok & Fredrickson, 2010).

These same participants were part of a larger investigation on the effects of increasing people's daily experiences of positive emotions and purpose. Accordingly, study participants were randomly assigned to learn loving-kindness meditation, or to serve in a monitoring waitlist control group. Loving-kindness meditation (LKM) involves the intentional cultivation of compassionate and caring sentiments for the self and others and thus can be taken as a recurrent, purpose-laden behavior. Indeed, field and laboratory experiments have found the practice of LKM to reduce depressive symptoms (Fredrickson et al., 2008), increase compassion and altruistic behavior (Hutcherson, Seppala, & Gross, 2008; Jazaieri et al., 2013; Klimecki, Leiberg, Lamm, & Singer, 2013; Leiberg, Klimecki, & Singer, 2011; Weng et al., 2013) and yield functional neural plasticity in brain circuits associated with positive affect and empathy (Klimecki et al., 2013; Weng et al., 2013).

The analyses reported above (i.e., Kok & Fredrickson, 2010) statistically controlled for experimental condition (LKM or waitlist) and in doing so revealed that upward spiral relations between changes in positive emotions (or purpose, indexed as social connectedness) and changes in cardiac vagal tone emerged across all participants, regardless of group assignment. Thus, dynamic reciprocal relations between biological attributes and social psychological wellbeing appear normative within non-clinical samples.

Might people be able to nudge this reciprocal dynamic to experience even greater biopsychosocial benefit? The larger intervention study had been designed to address this question. Whereas across the entire sample, participants who started the study with higher cardiac vagal tone tended to show larger increases in positive emotion and perceived social connectedness, slowly – week-by-week – those who were randomized to learn LKM began to show even larger increases. The significantly steeper increases in positive emotions and purpose that LKM produced were in turn associated larger improvements in cardiac vagal tone (Kok et al., 2013; see also Kok & Fredrickson, 2015; Fredrickson & Kok, 2017). The overall pattern of results suggests that a preexisting biopsychosocial reciprocal dynamic within individuals can be further stimulated by an ancient wellness practice that infuses daily life with emotional warmth and interpersonal tenderness.

Importantly, the effect of the LKM intervention on cardiac vagal tone was indirect. Model fit was best with changes in positive emotions and, sequentially, changes in perceived social connectedness were included as statistical mediators. Here again we see that experiences of positive emotions appear to serve as springboards for experiences of purpose, here indexed as feeling close and "in tune" with others. Social connectedness, the data suggest, appears to be one of the many durable resources that positive emotions function to build. In addition, the work described earlier in the present section (Isgett, Kok, et al., 2016) suggests that cardiac vagal tone functions as a biological vantage resource that amplifies the positive emotions felt during moments of connection. Finally, akin to the work described in the previous section on CTRA gene expression (Isgett, Boulton, et al., 2016), self-transcendent experiences of feeling connected to others appear to be more directly tied to improvements in physical health, as indexed by cardiac vagal tone. Here again, positive emotions and purpose appear to be intertwined in an upward spiral dynamic: Each may shape and be shaped by cardiac vagal tone in ways that reveal another facet of the biological underpinnings of the social psychology of a good life.

Oxytocin

Oxytocin is another biological resource with which my research team and I have found positive emotions and purpose to interrelate. Oxytocin is a polypeptide synthesized in the hypothalamus, which can be released into the bloodstream as well as to the forebrain. Our foray into this research area was inspired by data from human and non-human animals alike, which has suggested that oxytocin may specifically heighten the salience of social information (for reviews, see Bartz, Zaki, Bolger, & Ochsner, 2011; Shamay-Tsoory & Abu-Akel, 2016). Oxytocin in rodent mothers, for instance, appears to tune the auditory cortex to detect vocalizations from rodent pups, but has no impact on the detection of non-social auditory stimuli (Marlin, Mitre, D'amour, Chao, & Froemke, 2015). Similarly, oxytocin appears to tune the olfactory cortex to social odors, but not general odors (Choe et al., 2015). We reasoned that oxytocin might also amplify the affective rewards gained from benign or benevolent social interactions. To test this idea, our empirical approach has been to triangulate the oxytocin system from multiple angles: We have (a) assayed people's tonic, endogenous levels of oxytocin through bodily fluids; (b) classified individuals based on common variants of genes related to oxytocin signaling; and (c) administered a synthetic form of oxytocin exogenously in a randomized, double-blind experimental design. This section describes what my team and I have thus far learned through each of these approaches.

One investigation, led by Zan Isgett, capitalized on the long-standing evidence that social interaction is a reliable behavioral determinant of positive emotions. We examined whether individuals' tonic, endogenous levels of oxytocin moderated the link between sociality and positive emotions. In the same study (described earlier) in which cardiac vagal tone was found to amplify the positive emotions individuals experienced during social activities (i.e., Isgett, Kok, et al., 2016), we also measured these 73 participants' tonic levels of oxytocin. We did this by assaying urine each participant gathered over a 24-hour period. Results revealed that, as for cardiac vagal tone, tonic oxytocin moderated the association between the perceived sociality of an activity and the positive emotions experienced during it. Unlike cardiac vagal tone, however, tonic oxytocin did not predict the frequency of being in the presence of others. This pattern of results suggests that oxytocin and cardiac vagal tone may be linked to positive social experiences in somewhat distinct ways. Indeed, we found them to be uncorrelated (r = .04; CI [-.19, .27] p = .74). Even so, each appears to function as a biological vantage resource that renders people more responsive, in terms of positive emotions, to quotidian opportunities for social connection (Isgett, Kok, et al., 2016). Thus, like cardiac vagal tone, oxytocin appears to underpin, to an extent, the affective rewards that come from transcending the self to connect with others.

Another investigation, again led by Zan Isgett, tested whether common genetic polymorphisms related to oxytocin signaling might also modulate the positive emotions that people experience in contexts characterized by a high degree of benevolent sociality. Such findings would provide additional evidence that the oxytocin system functions as a biological vantage resource that underpins positive emotions and purpose. Midlife adults (N = 122) were randomly assigned to learn one of two forms of meditation, each taught over a 6-week period, while also reporting on their emotions daily (again using the mDES). One meditation practice was LKM (described in the previous section), which centers on cultivating benevolent attitudes toward other people. The comparison practice was mindfulness meditation (MM), which centers on stabilizing attention, without any particular focus on others. Study participants also provided blood samples, from which assays identified single nucleotide polymorphism (SNPs) within two genes important to oxytocin functioning, namely *OXTR* and *CD38*. Results revealed that individuals homozygous for the G allele of the *OXTR* rs1042778 SNP experienced gains in daily positive emotions with training in LKM (but not MM), whereas individuals with the T allele did not experience gains in positive emotions with either training. These findings are among the first to show that a common genetic difference in oxytocin signaling may amplify or mute the positive emotions that individuals experience when they adopt a benevolent social focus (Isgett, Algoe, Boulton, Way, & Fredrickson, 2016; see also, Algoe & Way, 2014).

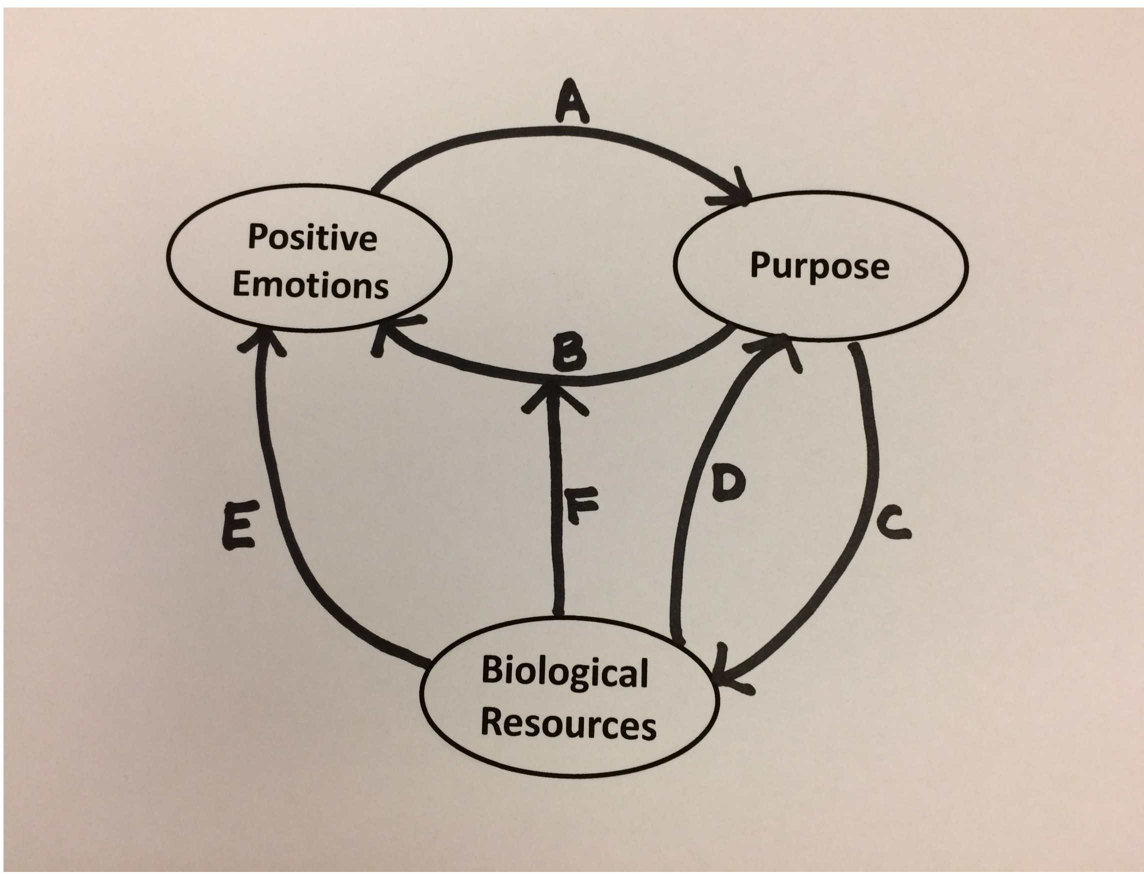
Our third study of the effects of oxytocin, led by Patty Van Cappellen, examined the links between oxytocin and spirituality, which is central to the experiences of purpose and meaning in life for millions of people worldwide. In keeping with past research, we define spirituality as one's personal affirmation of and relationship to a Higher Power, or to the sacred. Because the oxytocin system has been implicated in social bonding, we reasoned that it may also, to an extent, undergird spirituality. Although correlation studies had offered initial support for such an association (Holbrook, Hahn-Holbrook, & Holt-Lunstad, 2015; Kelsch et al., 2013), experimental evidence was lacking. To provide such evidence, we randomly assigned 83 midlife males to receive intranasal oxytocin or a placebo, using a double-blind experimental design. For exploratory analyses, participants were also genotyped for SNPs within *OXTR* and *CD38.* Analyses revealed that oxytocin increased participants' self-reports of spirituality that same day, as well as one week later. Oxytocin also boosted the positive emotions participants experienced during an initial exposure to meditation practice, either LKM or MM. This effect was particularly pronounced for the self-transcendent positive emotions of awe, gratitude, inspiration, and love (Van Cappellen, Way, et al., 2016). So here again oxytocin functions as a biological vantage resource, one that enhances the affective rewards of meditation, which for many people is perceived as laden with meaning and purpose. Our confidence in this result is strengthened because it emerged through both explicit and implicit measures of positive affect. Mediational analyses also suggested that increases in spirituality accounted for the more positive affective responses to meditation that emerged in the oxytocin condition. Finally, our inference that the effects observed are indeed due to action within the oxytocin system is supported by exploratory analyses, which found genetic variation in *CD38* and, to a lesser extent, *OXTR* to moderate the effects of intranasal oxytocin administration (Van Cappellen, Way, et al., 2016). So here again we find that oxytocin functions as a biological vantage resource, one that boosts self-transcendent experiences of spirituality as well as the affective rewards of a purpose-laden activity (i.e., meditation).

Integration and Implications

Across this range of studies, my collaborators and I have uncovered evidence for multiple pathways by which biological attributes underpin positive emotions and purpose. Integrating this range of evidence, I speculate here about one possible overarching model, as illustrated in the accompanying Figure. First, we know from past research that positive emotion and purpose are themselves intertwined in an upward spiral dynamic. That is, positive emotions have been found to predict and cause increases in purpose (Path A; Hicks et al., 2010; Hicks et al., 2012; King & Hicks, 2009; King et al., 2006), and likewise, aspects of purpose have been found to predict and cause increases in positive emotions (Path B; Fredrickson et al., 2008; Yamasaki, Uchida, & Katsuma, 2009). In research described in the present chapter, my team and I have uncovered evidence for Path C, that purpose shows an association with biological attributes, namely CTRA gene expression profiles (Fredrickson, Algoe, et al., 2015; Fredrickson et al., 2013) and cardiac vagal tone (Kok et al., 2013) that is more direct than the link between positive emotions and these same biological attributes (along Path A, then Path C; Isgett, Boulton, et al., 2016; Kok et al., 2013). We've also found that cardiac vagal tone predicts (Isgett, Kok, et al., 2016) and oxytocin causes (Van Cappellen, Way, et al., 2016) increases in purpose (Path D). In addition, we found these same biological attributes to predict and cause positive emotions, either directly (Path E; Kok et al., 2013; see also Kok & Fredrickson, 2015), or indirectly (Path D to Path B; Van Cappellen, Way, et al., 2016). Finally, we also find evidence that biological attributes function as vantage resources: that is, the association between purpose and positive emotions (Path B) is strengthened (moderated) by biological attributes (Path F), namely cardiac vagal tone (Isgett, Kok, et al., 2016) and oxytocin (Isgett, Algoe, et al., 2016; Isgett, Kok, et al., 2016).

The emergent overarching model thus implies two distinct ways that individuals' biological attributes may underpin the upward spiral dynamic between positive emotions and purpose (Paths A and B). First, biological attributes may join in this upward spiral dynamic such that positive emotions, purpose, and certain biological attributes mutually build on one another, either directly (Paths C, D, and E) or indirectly (along Path A then Path C). Second, biological attributes may also function as vantage resources (Path F) that augment the affective rewards of purpose laden activities. Taken as a whole, this model implies that positive emotions and purpose serve to build healthier levels of various biological attributes, either directly or indirectly, and that these accumulating biological resources advantage individuals further by amplifying the positive emotion yield of purpose-laden activities, which in turn accelerates the hypothesized biopsychosocial upward spiral dynamic even more so. (Whereas the model sketched here shares features in common with my upward spiral theory of lifestyle change [Fredrickson, 2013; Van Cappellen, Rice, et al., 2016], namely the acceleration factor represented by the outer loop, the inner loop dynamics of each model are articulated at different levels of analysis.) Whether and to what extent the model depicted in the Figure faithfully describes how biological attributes underpin positive emotions and purpose merits further testing, with particular emphasis on longitudinal and experimental research designs.

To sum, long-standing evidence has shown that psychological and physical health are related. The provisional model articulated here and portrayed in the Figure drills deeper than mere correlations to add specificity about the mechanisms and moderators that undergird this well-documented relationship. Insight into how, when, and for whom psychological and physical health interrelate can reveal how, when, and for whom practitioners might best intervene to promote good lives for more people.



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