

Considerations about a psychophysiological perspective of love

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Abstract

Aristotle considers passions (emotions) as affections of the human soul involving a body. Concretely, gentleness, fear, pity, courage, joy, loving, and hating involve corporal changes, concurrent affections of the body. For Aristotle, the passions of the soul or emotions are enmattered accounts (DA, 403a20-25).

With the development of cognitive science and neuroscience, a lot of the current emotion research studies the biological and neurological substrates of emotions. Within contemporary psychology research, Barbara L. Fredrickson's provocative approach deals with love's biology, studying the biological underpinnings of love and suggesting a body's definition of love.

After exposing Fredrickson's concept of love, I discuss some conceptual aspects of this perspective, taking into consideration the unity of the human being and its different features in order to avoid reductionist explanations or conclusions that may lack reflection on the different epistemological levels of Philosophy, Psychology and Neuroscience.

Keywords: love, positive emotion, social interaction, psychological and neurophysiological research, Barbara L. Fredrickson

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1 INTRODUCTION

Since approximately the second half of the twentieth century, social psychologists have started to do psychobiological research on emotions, using physiological and neuroscience measurements. Magda B. Arnold (1903-2002), one of the pioneers in the study of emotions explained in the sixties that the principal questions psychologists faced were how emotion is aroused, why a perceived object gives rise to this state or fails to do so, and how emotion, once aroused, can influence action. The analysis of the process from perception to emotion and action, suggested the necessity to complete it with recourse to neurological research. Emotional expression, autonomic changes and overt action imply functioning circuits in the brain; hence no explanation can be complete unless it shows what is happening in the brain during emotion.¹

Around these years, authors from different psychological orientations (behaviourism, cognitivism) focused on the neuropsychological research of emotions by studying the interplay between psychological and physiological processes.²

After the generation of these researchers, and since more than twenty years within the field of Positive Psychology, Barbara Fredrickson has been leading neuropsychological research on positive emotions, connecting them with personal flourishing. As a result of her research she has developed the theory of broaden-and-build effects of positive emotions.³

By positive emotions, Fredrickson understands a range of discernible pleasant affective states, including joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe, and love. This list is not exhaustive, instead it groups together ten representative positive emotions that research suggests people experience with some frequency in daily life. Like all emotions, positive emotions are brief, multisystem activation patterns related to changes in the way people appraise their present circumstances. An individual's past experiences and current situation ultimately shape the emotion(s) that will be experienced. When these multisystem 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. Love is the most frequently experienced positive emotion. Love broadens thought-action repertoires by creating momentary perceptions of social connection and self-expansion. Likewise, love builds a wide range of enduring resources, especially social bonds and community.⁴

2 A PSYCHOPHYSIOLOGICAL CONCEPT OF LOVE

Love is one of the positive emotions studied by Fredrickson, the main emotion. Love is not a single emotion but rather a complex feeling experienced by people in all its varieties (romantic, friendship, familiar bonds, etc.). According to Fredrickson, we need to distinguish between love relationships and love experiences, even if in love relationships there can be a lot of love experiences. People have love relationships with intimates, loved ones. Love experiences instead are wider and can occur among strangers. While love relationships last long time, love experiences are momentary.

The psychophysiological concept of love explained here is related then to the context of love experiences, where love is experienced as a moment of connection or, in Fredrickson's terms, *positivity resonance*, as explained below.

From this psychophysiological perspective, love can be defined as an emotion, a momentary state of shared positive emotions (i.e. joy, awe, interest) ⁵between two or more people, that arises to infuse mind and body alike, creating a biochemical resonance which alters the activity within one's body and brain in ways that trigger parallel changes within another person's body and brain. This true sensory and temporal connection is characterized by mutual care and is accompanied by a feeling of oneness, between two or more intimate people or even between strangers.⁶

In this notion of love, there are three defining attributes: shared positive emotions, bio-behavioral synchrony, and mutual care.

As mentioned, love is a fleeting state when sharing other positive emotions with people, so that love comprises any other positive emotion that is felt in the context of connection with others, be it interest, joy, or other positive emotion. For example, when in a public transport we make eye-contact with the child of a woman seated beside us and start exchanging smiles, even laughs.

Like all emotions love sparks motivational changes. Concretely, love motivates mutual care:

“Each person, in a moment of shared positivity, becomes momentarily invested in the other's well-being(...) The momentary experience of love brings an urge to focus on the other person, holistically, with care and concern for his or her well-being, a motive that momentarily eclipses any tendency toward self-absorption. And this caring motive is mutual, reflected back and forth between the two”.⁷

Love makes people more open to others. According to Fredrickson when people are feeling good —under the influence of positive emotions— their sense of self expands to include others. On the contrary, when someone is feeling bad, experiencing any negative emotion (anger, anxiety, sadness, etc.) or nothing special the person is more self-focused.

The reason is that when people feel positive emotions, over time, these positive emotions become associated with greater feelings of self-other overlap and oneness, and this broadened sense of self may predict a more complex understanding of others.⁸

Fredrickson stresses the importance of finding the ways that help to build up the natural tendency to be a little bit more other focused than self-focused. It is kind of building the habit to transform oneself in a more benevolent person.

The third element in this perspective of love is biobehavioral synchrony, which

“refers to the mirroring across people’s behaviors, bodies, and brains that each moment of shared positive emotional connection creates”.⁹

A study about nonverbal gestures of people getting to know each other showed that nonverbal biobehavioral synchrony is a key mechanism through which self-disclosure produces an embodied sense of understanding.¹⁰ It appears then that when people share a positive emotional state, they also share gestural, biochemical, and neural patterns. A biobehavioral unity or oneness unfolds.

Fredrickson explains that when these three elements co-occur, love is experienced as *positivity resonance*:

“Within moments of interpersonal connection that are characterized by this amplifying synchrony—of shared positive emotions, biobehavioral synchrony, and mutual care—resource-building positivity resonates between and among people. This back-and-forth reverberation of positive emotional energy sustains itself—and can even grow stronger—until the momentary connection inevitably wanes”.¹¹

Besides love’s elements, two pre-conditions are necessary for love emerging as resonance: a sense of safety and temporal or sensory connection. It needs to be physical and a real time connection for our physiological responses to mirror each other. The most common sensory connections are eye-contact, voice, touch, and mirrored body postures and gestures.

Notwithstanding, based on cultural variation, one could object that the safety condition might be relative in different cultures. For instance, establishing when it is appropriate to smile or have eye contact. Fredrickson explains that when people feel safe, humans are designed in a way that their reaction to smiles can be very similar. The emotions are a field where there is a lot of cultural variation, and a lot of universality at play, simultaneously.¹²

Based on findings from neuroscience, Fredrickson’s research explains that love is a social engagement system,¹³ describing love’s biology as a system with

three main interacting parts that work in the neurophysiological background supporting people's social interactions and love experiences: the brain (neural coupling), the hormone oxytocin, the vagus nerve (vagal tone).

Working on brain imaging, that is, using fMRI (functional magnetic resonance imaging) of people's brains while either telling or listening to an engaging story, the neuroscientist Uri Hasson and colleagues found widespread brain coupling between speaker and listener, especially during emotional moments and for pairs for whom communication is particularly effective.¹⁴

What Hasson found was more than isolated mirror neurons,¹⁵ indeed a far more extensive neuronal coupling through which occurs people's mutually understanding. Hasson even claims that communication is a single act performed by two brains.¹⁶

Hasson's findings revealed that a key brain area that showed coupling in his speaker-listener study was the insula, which is linked with conscious feeling states. Synchrony in two people's insulae suggests that in good communication, two individuals come to feel a single, shared emotion as well. In other work, Hasson and colleagues have shown that people's brains come particularly into sync during emotional moments.¹⁷

If sharing the same emotion in a good connection with another person is reflected in neural coupling, then a micro-moment of love is a single act, performed by two brains. Research on self-other overlap at the neuronal level shows that when imagining painful events happening to a loved one, and the loved one's pain becomes your pain, then the brain activity of both is virtually indistinguishable.¹⁸

The hormone oxytocin is a polypeptide synthesized in the hypothalamus, which can be released into the bloodstream as well as to the forebrain, so that it acts within brain and body, playing a key role in social bonding and attachment. Recent research in this area has suggested that oxytocin may specifically heighten the salience of social information.¹⁹

Concretely, a study on the changes in oxytocin within parents and their infants engaged in face-to-face play, has shown that positivity-infused behavioral synchrony, through a mother or father's eye contact (affectionate touch and smiles) together with their infant, predicts a synchrony between the oxytocin surges evident within both them and their infant. A biochemical synchrony can emerge, supporting mutual engagement, care and responsiveness, as in the case of the interaction between parents and babies, but not only. There is research evidence that oxytocin surges are present when forming new social bonds or simply cementing existing ones.²⁰

The third biological attribute is the vagus, the tenth cranial nerve, that goes from brain stem to various internal organs, mainly the heart and lungs. In contrast to a "fight or flight" autonomic response, which is orchestrated by the body's

sympathetic nervous system, the vagus nerve has been implicated—together with oxytocin—in a “calm and connect” autonomic response, which is orchestrated by the parasympathetic nervous system. Thus the vagus nerve is involved in the body’s ability to flexibly and efficiently respond to changing circumstances.²¹

Usually the strength of the vagus nerve is measured by tracking people’s heart rate in conjunction with their breathing rate. Like muscle tone, higher levels of cardiac vagal tone are better than lower levels. Research evidence has shown that people with higher vagal tone are more flexible across different domains (physical, mental, social); they regulate their bodily processes more efficiently, like their glucose levels and inflammation; they regulate better their attention and emotions, even their behavior;²² and they are especially skillful in social interactions and forging positive connections with others. Compared to people with lower vagal tone, those with higher vagal tone experience more love in their daily lives, more moments of positivity resonance.²³

Even if it is not included in this explanation of love’s biology system, *gene expression* has caught also Fredrickson’s research attention. By tracking how emotions, and the biochemical changes they trigger, alter gene expression within the human immune system, the tools of molecular biology show how a lack of love compromises immunity and health. Fredrickson and colleagues have been studying the ways that oxytocin and other ingredients that make up love’s biochemistry trigger healthy changes in gene expression that may foster physical and mental well-being.²⁴

Fredrickson states that all of love’s unseen biological transformations—in brain rhythms, blood stream, vagus nerve, and cells—in turn prepare individuals to become more attuned to love (connection), better equipped, biologically, to cultivate moments of positivity resonance with others. She concludes that human biology enacts and embodies people’s experiences of love.²⁵

Based on Niedenthal and colleagues’ research, Fredrickson suggests that in the sphere of social interactions there is a lot of embodied cognition: the knowing is not just abstract and conceptual, it is embodied and physical. For example: through eye contact and close attention to all manner of smiles, our personal appraisal about who to trust and who not to trust become more reliable.²⁶

Using a metaphor, Fredrickson points out that our body is more verb than noun: it shifts, cascades and pulsates; it connects and builds; it erodes and flushes. The body acts as a verb, in the sense the body takes action, and broadcasts everything one feels—the moments of positivity resonance or their lack—to every part of us, readying us for either health or illness and rendering us either more or less equipped for loving connection. In a few words, the biology of love in action consists in the ways positivity resonance can synchronize one’s brain and oxytocin waves with those of another, and how, over time, it can build the capacity of the vagus nerve, which points individuals toward physical health, social skill, and

overall well-being. Nonetheless, as Fredrickson warns, a fully integrated view of love cannot end with biology. It demands to rise above for considering the ways that love also infuses all that lies beyond our physical body, its effects on actions and relationships, wisdom and spiritual potential.²⁷

3 COMMENTARY

In Fredrickson's perspective of love there are many helpful insights for emotion research and notable work to show scientific empirically based studies. Like in other contemporary psychological works, the view presented here entails a mix, a hybrid of biology and psychology, that renders philosophical analysis more difficult. It requires an effort of translation-conceptualization of the terminology used.

As stated, there is a tendency among emotion researchers in psychology to engage in neurophysiological studies to support or better explain the biological substrates of emotion. Yet Arnold's work moved on this direction, though warning about reductionist explanations.²⁸ Similarly, other psychologists like R. Lazarus (1922-2002), who studied especially the relation between emotion and thought, was opposed to explain all human behavior by looking at the structure of the brain.

Logically, engaging in neurophysiological studies within the field of emotion research does not imply necessarily to fall into reductionist approaches. But it could be the case, if the different epistemological levels of Philosophy, Psychology and Neuroscience are not sufficiently considered.

The contributions from the interdisciplinary work of Psychology and Neuroscience must be placed then within an adequate epistemological context, mostly empirical, between biology and social psychology. The analysis of human emotion can be developed, thus, integrating the neurophysiological, phenomenological and ontological levels. Each of them brings their perspective. Philosophy, taking into account data from ordinary experience as well as from scientific knowledge so as not to digress in the empty, brings an essential meaning to that knowledge. Science, concretely neuroscience, along with cognitive sciences like psychology, provides knowledge concrete and empirical.²⁹

Neurobiological studies have a partial, but not irrelevant, role specifically relative to human cognitive and affective states and operations. Interdisciplinary work on emotion demands a dialogue among philosophy, psychology and neuroscience, first of all, about terminology. In my opinion, a work on conceptualization-definition is frequently missed in psychological studies. Obviously it does not imply that (neuro)psychological studies must delve into philosophical argumentations nor the contrary —even if some neuroscience

research does that—³⁰ rather it is enough an acknowledgement of the different epistemological levels.

Yet Aristotle asked how should be a definition of one affection of the soul in the science of nature. He realized that different disciplines define in a different way the same affection: a physicist —a scientist— would define an affection of soul differently from a dialectician —a philosopher—. For example, anger would be defined by a dialectician as the appetite for returning pain for pain, while a physician would define it as a boiling of the blood or warm substance surrounding the heart. Following the explanation in Aristotelian terms, while the physician assigns the material conditions, the philosopher assigns the form or account; "for what he states is the account of the fact, though for its actual existence there must be embodiment of it in a material such as is described by the other".³¹

Fredrickson's insights highlight the embodied condition of love as emotion and other human capacities. When approaching whatever dimension of human flourishing —virtues, emotions, relationships, mental and physical health, spiritual dimension, etc.—, the essential key is therefore the consideration of the unity of the human being. It is true that we do not have intuitive access to the unity between the mental (psychic) and the neuronal. Science lets us glimpse this unity, which we understand as *correlation*, that is, we grasp it indirectly, as rational conclusion. Because of that it surprises and delights us that some physical structure, for example the layout of retinal cells, makes the visual act emerge. It is difficult to understand why it needs to be like that, but this gap between the psychic and the physical always subsists.³²

Even if analytically we distinguish the soul-body, mind-brain binomials, the human person moves and acts in extraordinarily unity like a whole. As Allport said, quoting Lavater's statement "one and the same spirit is manifest in all".³³ That is another reason why an interdisciplinary work is needed.

From an Aristotelian-Thomist view, emotions are linked to corporal structures and brain functions, and their essential material cause is the neural basis.³⁴ Then, love is linked to brain functions by having neural basis —as Fredrickson's research shows—, which however do not explain all what is love as an emotion —even less what is love as a virtue—, but as material cause, brain functions are *conditio sine qua non* of love, and emotions in general.

Emotions, thoughts, consciousness, intentions, decisions are rather psychosomatic operations and states, in that they include a psychological dimension as a dynamical and unitary whole including the body.³⁵

The psychic act is, therefore, always psychosomatic, and because of the property of intentionality it can also be said that is intrinsically relational, open to the world and not closed in its own immanence. In other words, the individual mind is not confined within the head, but extends throughout the living body and includes the world beyond the skull, especially the social world of self and other;

and this is also the world in which mind and brain are essentially formed.³⁶ This can explain Fredrickson's remarks on relatedness and how love in her perspective can open ourselves to other people. It is a kind of cognitive and affective openness, interesting to be explored more.

In these terms, what Fredrickson argues is that love as a positive emotion brings us in social cognition and the perception of the other, which is always based on social inter-action, and implies embodied inter-subjectivity. It can be showed that from birth on, everyone posses interpersonal body schemas for spontaneous facial imitation and emotional resonance, experiencing the other's body as similar to our own. Thus, embodiment and inter-affectivity form the basis of social understanding through an interactive practice of meaningful and expressive bodies.³⁷

Personal interrelations imply, in this sense, the reciprocal and dynamical co-existence of each one in the cognitive and affective workspace of other people in many respects; however friendly relations, familiar relations or wider collective relations are very different in quality and cannot be considered univocally.³⁸

Is then Fredrickson's perspective a reductionist concept of love? Apparently one could say yes, but even if not expressed in these terms, she is aware of the different epistemological levels, concretely when she explains that love cannot stop with biology or in other words that biology cannot explain all that is love. In addition, Fredrickson states that the essential feature of love —that spans all varieties of love, from romantic to parental— is care and concern for another, for his or her own sake. She recognizes the different quality of love relationships, and bonds. But as developed in the previous section, the consideration of love as an emotion or affect —even in its fleetingness— under a psychophysiological perspective refers to moments of affective connection when sharing positive emotions, which is a common element of the different love bonds. This explains also the possibility to experience sympathy even with people we first meet.³⁹

Another question arises: Is it possible to study love from a biopsychological perspective without an anthropological view? Probably not. It is always in the background an anthropological view even if it is not so defined. It seems that there are in Fredrickson's perspective of love many un-themed anthropological assumptions. From her work can be supposed an implicit notion of human nature, an assumption of the unity of human being, and a concept of what a good person is, even if she does not speak in terms of virtues.⁴⁰

Last but not least, other themes that Fredrickson's perspective of love open are the relations of causality between love as a positive emotion, and physical and mental health and well-being. It appears that there are reciprocal causalities because of the circularity of the embodied mind. But to which extent can we affect/influence our biology? More basic, what is first, the biological or the psychological aspect? The latter has been answered above, they both are correlated

aspects. But still as Arnold exposed, one of the problems in emotion research is how are correlated bodily symptoms (physiological-neurophysiological) and the psychological experience.⁴¹

As Fuchs explains, neuronal processes make the experience of feelings possible. But making possible does not mean causation, for conversely it is also true that only meaningful biographical experiences have made the neuronal processes possible in their specific form. For example, shame can be described in a dual aspect mode: on the one hand as a complex concatenation of physiological mechanisms, on the other hand as a biographically understandable reaction to an interpersonal situation. However, Fuchs states, there is no reciprocal causation involved; rather, the person as a living being embodies and encompasses both aspects.⁴²

The former question is even more difficult to answer. In her research, Fredrickson looks at the prospective and reciprocal relations between positive emotionality and the physical resources. She also aims to find out if love's biochemistry trigger healthy changes in gene expression that may foster physical and mental well-being.⁴³ At an experimental level these implications are not easy to prove, many variables must be controlled. Though we know by experience that our psychology (mental well-being) affects our biology (physical well-being) and our physical well-being influences also our mental well-being. At least, we can say with Aristotle that every modification of the soul involves a modification of the body and vice versa. Thus, a proper treatment of the body—in the case of mania— or its success resides not only in altering the physical condition, but also simultaneously in curing the soul of mania; and “*the fact that the changes are simultaneous proves that the sympathetic modifications of body and soul are thoroughly concomitant*”.⁴⁴

Fredrickson's perspective of love could be still enriched with philosophical analysis and/or commentaries based on the study of Aristotle's psychology, ethics and natural philosophy, together, and with some phenomenological considerations from Merlau-Ponty.⁴⁵

NOTES

1. See Magda Arnold, *Emotion and personality, vol. 1-2, Psychological aspects*, Columbia University Press, New York 1960, pp. 172–190.
2. To name just a few authors: Jaak Panksepp, Antonio Damasio, Gerald M. Edelman, Jean-Pierre Changeux, John T. Cacioppo, Paul Ekman, Robert Levenson, Michael Arbib.
3. At present Barbara Fredrickson is Kenan Distinguished Professor in the Department

- of Psychology & Neuroscience leading the Positive Emotions and Psycho-physiological Laboratory (a.k.a. the PEP Lab) at the University of North Carolina (UNC) Chapel Hill, USA. For more information about her theory, see: Barbara L. Fredrickson, *What good are positive emotions?*, "Review of General Psychology", 2 (1998), pp. 300–319; Barbara L. Fredrickson, *The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions*, "American Psychologist", 56 (2001), pp. 218–226; Barbara L. Fredrickson, *Positive emotions broaden and build*, "Advances in Experimental Social Psychology", 47(2013), pp. 1–53.
4. See B. L. Fredrickson, *Positive emotions broaden and build*, cit., p. 6.
 5. Fredrickson adopted a perspective of love as sharing any emotion with others based on Carroll Izard's work. See C.E. Izard, *Human Emotions*, Springer, New York 1977.
 6. See B. L. Fredrickson, *Positive emotions broaden and build*, cit., p. 42.
 7. B. L. Fredrickson, *Positive emotions broaden and build*, cit., p. 41.
 8. See Christian E. Waugh, Barbara L. Fredrickson, *Nice to know you: Positive emotions, self-other overlap, and complex understanding in the formation of a new relationship*, "The Journal of Positive Psychology", 1/2 (2006), pp. 93–106.
 9. B. L. Fredrickson, *Positive emotions broaden and build*, cit., p. 41.
 10. See T. Vacharkulksemsuk, B.L. Fredrickson, *Strangers in sync: Achieving embodied rapport through shared movements*. "Journal of Experimental Social Psychology", 48/1 (2012), pp. 399–402.
 11. B. L. Fredrickson, *Positive emotions broaden and build*, cit., p. 42.
 12. Fredrickson does not speak in terms of human nature, but she is probably referring to that.
 13. Fredrickson took the term social engagement system (SES) from the neuroscientist Stephen Porges. See Stephen W. Porges, *Social engagement and attachment: A phylogenetic perspective*, "Annals of the New York Academy of Sciences", 1008 (2003), pp. 31–47. See also Stephen W. Porges, *The polyvagal theory: new insights into adaptive reactions of the autonomic nervous system*, "Cleveland Clinic journal of medicine," vol. 76 Suppl 2 (2009), pp. 86–90.
 14. See Barbara L. Fredrickson, *The biological underpinnings of positive emotions and purpose*, in R. Baumeister, J. Forgas (eds.), *The Social Psychology of Living Well*, Psychology Press, New York 2018, pp. 163–180.
 15. See Antonio Malo, *Mirror neurons and morality*, in Sanguinetti et al. *Moral Behaviour and Free Will: A Neurobiological and Philosophical Approach*, STOQ Project, IF Press, Morolo (Italy) 2011, pp. 319–331. Findings on mirror neurons' research offer interesting insights into relatedness and otherness.
 16. See U. Hasson, *I can make your brain look like mine*, "Harvard Business Review", 88/12 (2010), pp. 32–33; G.J. Stephens, L.J. Silbert, U. Hasson, *Speaker-listener neural coupling underlies successful communication*, "Proceedings of the National Academy of Sciences of the United States of America", 107/32, (2010) pp. 14425–14430.
 17. See U. Hasson, Y. Nir, I. Levy, G. Fuhrmann and R. Malach, *Intersubject synchronization of cortical activity during natural vision*, "Science", 303 (2004), pp. 1634–1640. See also Craig, A.D. (Bud), *How do you feel — now? The anterior insula and human awareness*, "Nature Reviews Neuroscience", 10 (2009), pp. 59–70.
 18. See B. L. Fredrickson, *Love 2.0*, Hudson Street Press/Penguin, New York 2013, p. 46.

19. See B. L. Fredrickson, *The biological underpinnings of positive emotions and purpose*, cit., p. 171.
20. See B. L. Fredrickson, *Positive emotions broaden and build*, cit., p. 41, where she refers to the work of R. Feldman, I. Gordon, & O. Zagoory-Sharon, *The cross-generation transmission of oxytocin in humans*, "Hormones and Behavior", 58/4 (2010), pp. 669-676. See also B. L. Fredrickson, *Love 2.0*, cit., p. 51.
21. See B. L. Fredrickson, *Positive emotions broaden and build*, cit., p. 26-27.
22. See Stephen W. Porges, Jane A. Doussard-Roosevelt, & Ajit Maiti, *Vagal tone and the physiological regulation of emotion*, "Monographs of the Society for Research in Child Development", 59/2-3 (1994) pp. 167-186.
23. See Bethany E. Kok, Barbara L. Fredrickson, *Upward spirals of the heart: Autonomic flexibility, as indexed by vagal tone, reciprocally and prospectively predicts positive emotions and social connectedness*, "Biological Psychology", 85 (2010), pp. 432-436.
24. See Barbara L. Fredrickson, Karen M. Grewen, Kimberly A. Coffey, Sara B. Algoe, Ann M. Firestine, Jesusa M.G. Arevalo, Jeffrey Ma, and Steven W. Cole, *A functional genomic perspective on human well-being*, PNAS 110/33 (2013), pp. 13684-13689, <https://doi.org/10.1073/pnas.1305419110>.
25. See also B. L. Fredrickson, *Love 2.0*, cit., p. 58.
26. See Paula M. Niedenthal, Martial Maermlod, Marcus Maringer, and Ursula Hess, *The Simulation of Smiles (SIMS) model: Embodied simulation and the meaning of facial expressions*, "Behavioral and Brain Sciences", 33/6 (2010), pp. 417-480. This study integrates behavioral research from social psychology with recent research in neurosciences. The roles of several of the brain's reward systems, and the amygdala, somatosensory cortices, and motor centers are examined, and then linked to behavioral and brain research on facial mimicry and eye gaze. The authors present also a model of the processing of the smile—the most complex of the facial expressions—as a means to illustrate how to advance the application of theories of embodied cognition in the study of facial expression of emotion.
27. See B. L. Fredrickson, *Love 2.0*, cit., p. 38, 59.
28. See Pia Valenzuela, *Magda B. Arnold's work on the integration of Philosophy and Psychology perspectives on Human Emotion* (forthcoming).
29. See Juan José Sanguinetti, *El desafío antropológico de las neurociencias. Neurociencia, filosofía y teología*, "Rivista di Scienze dell'educazione", 52/3 (2015), pp. 383-400.
30. See Michael A. Arbib, *Your soul is a distributed property of the brains of yourself and others*, in "Reti, saperi, linguaggi. Italian Journal of Cognitive Sciences," 1 (2016), pp. 5-30, doi: 10.12832/83914 .
31. See *On the Soul* (DA) 403a20-403b20. I follow the translation of J.A. Smith, *On the Soul*, in *The Complete Works of Aristotle*, The Revised Oxford Translation, vol. 1, Jonathan Barnes (ed.), Princeton University Press, Princeton 1984.
32. See J.J. Sanguinetti, *El desafío antropológico de las neurociencias. Neurociencia, filosofía y teología*, cit., p. 386.
33. Allport refers to Lavater's work who taught him that all the features of the body are ultimately congruent and consistent, so that is a consistency of personality both in its inward aspects and in its expression. See Gordon Allport, *Personality: a Psychological Interpretation*, Henry Holt and Company, New York 1937.

34. See J.J. Sanguinetti, *El desafío antropológico de las neurociencias*. *Neurociencia, filosofía y teología*, cit., p. 390.
35. See J.J. Sanguinetti, *Soul and Person. Commentary on Your soul is a distributed property of the brains of yourself and others by Michael A. Arbib*, “Reti, saperi, linguaggi. Italian Journal of Cognitive Sciences,” 2/2016 a. 5 (10) pp. 243–252.
36. See Thomas Fuchs, *Mind, brain and life: the paradigm of embodiment*, keynote XXIV Convegno Internazionale di studi della Facoltà di Filosofia, *Natura umana, anima e corpo. Convergenza di prospettive*, Pontificia Università della Santa Croce, Roma, March 18-19th 2019.
37. See T. Fuchs, *Mind, brain and life: the paradigm of embodiment*, cit.
38. See J.J. Sanguinetti, *Soul and Person*, cit., p. 250.
39. Notwithstanding, a further question may arise: Is love as resonance or connection only present when sharing positive emotions? What if we share negative emotions with a loved one, for example feelings of grief and compassion: is that love anyway, are not they moments of resonance with someone else?
40. Fredrickson does not refer to virtues nor to human good when explaining well-being or flourishing. See Pia Valenzuela, *Happiness without Morals* (forthcoming).
41. Arnold suggested that it is about the body-mind relation and that from time to time one or other facet of emotions was emphasized. See M.B. Arnold, *Perennial problems in the field of emotion*. In M.B. Arnold (ed.), “Feelings and emotions: The Loyola Symposium”, Academic Press, New York 1970, pp. 169-186.
42. See T. Fuchs, *Mind, brain and life: the paradigm of embodiment*, cit.
43. Fredrickson’s concept of ‘upward spiral dynamics’ relates to the prospective mutual influences or reciprocal relations between positive emotions and mental and/or physical health. See B.L. Fredrickson, T. Joiner, *Positive emotions trigger upward spirals toward emotional well-being*, “Journal of Personality and Social Psychology”, 65/1 (2002), pp. 45–55; B.E. Kok, B.L. Fredrickson, *Upward spirals of the heart: Autonomic flexibility, as indexed by vagal tone, reciprocally and prospectively predicts positive emotions and social connectedness*, “Biological Psychology”, 85/3 (2010), pp. 432–436; B.E. Kok, K. A. Coffey, M.A. Cohn, L.I. Catalino, T. Vacharkulksemsuk, S.B. Algoe, B.L. Fredrickson, *How positive emotions build physical health: Perceived positive social connections account for the upward spiral between positive emotions and vagal tone*, “Psychological Science”, 24/7 (2013), pp. 1123–1132; B.E. Kok, B.L. Fredrickson, *Evidence for the upward spiral stands steady: A response to Heathers, Brown, Coyne, and Friedman*, “Psychological Science”, 26/7 (2015), pp. 1144–1146; B.L. Fredrickson, T. Joiner, *Reflections on positive emotions and upward spirals*, “Perspectives on Psychological Science”, 13/2 (2018), pp. 194–199.
44. Emphasis are added. From the pseudo-Aristotelian treatise *Physiognomonica* (*Physiognomonics*) is this whole paragraph: “Soul and body, as it seems to me, are affected sympathetically by one another: on the one hand, an alteration of the state of the soul produces an alteration in the form of the body, and contrariwise an alteration in bodily form produces an [15] alteration in the state of soul. Grief and joy, to take an instance, are states of the soul, and everyone knows that grief involves a gloomy and joy a cheerful countenance. Now if it were the case that the external expression persisted after the soul had got rid of these emotions, we might still say that soul and body are in sympathy, but their sympathetic changes would not be entirely concomi-

tant. As a [20] matter of fact, however, it is obvious that every modification of the one involves a modification of the other. The best instance of this is to be found in manic insanity. Mania, it is generally allowed, is a condition of the soul, yet doctors cure it partly by administering purgative drugs to the body, partly by prescribing, besides these, certain courses of diet. Thus, the result of proper treatment of the body is that they succeed, and that too simultaneously, not only in altering the physical condition, but also in curing the soul of mania; and the fact that the changes are simultaneous proves that the sympathetic modifications of body and soul are thoroughly [25] concomitant” (Aristotle, *Physiognomonics* 808b10-25). See the edition of T. Loveday and E.S. Forster in *The Complete Works of Aristotle*, The Revised Oxford Translation, vol. 1, Jonathan Barnes (ed.), Princeton University Press Princeton 1984.

45. I refer especially to Aristotle psychological treatise *De Anima*, ethical works as *Ethica Nicomachea*, *Rhetoric* and natural science studies *Parva Naturalia*, *De Animalibus*, and the already mentioned pseudo-Aristotelian treatise *Physiognomonica*. Merleau-Ponty’s concept of ‘intercorporeality’ (intercorporéité) may be useful for Fredrickson’s approach to love. Intercorporeality means a pre-reflective intertwining of lived and living bodies, in which my own is affected by the other’s body as much as his by mine, leading to an embodied communication. See M. Merleau-Ponty, *Le philosophe et son ombre*, in “Signes”, Éditions Gallimard, Paris 1960; M. Merleau-Ponty, *Phenomenology of Perception*, Routledge, London 1962. See also T. Fuchs, *Intercorporeality and Interaffectivity*, “Phenomenology and Mind,” 11 (2016), pp. 194–209.

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