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Chapter 7

Fredrickson's Broaden-and-Build Theory, Chemical Engineering, and Systems Intelligence

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The broaden-and-build theory of positive emotions of Barbara L. Fredrickson argues that positive emotions broaden momentary thought-action repertoires and build longterm intellectual, physical and physiological resources. In this paper the broaden-and-build theory is approached from the point of view of chemistry as a platform for illuminating generative metaphors. Fredrickson's theory of positive emotions is interpreted in terms of catalysts, and discussed using key chemical terms such as porous material, activation energy and coke. We further link chief insights of Fredrickson's theory with the systems intelligence approach of Raimo P. Hämäläinen, Esa Saarinen and their associates. We offer an outline of a perspective on human growth based on chemical metaphors, conceiving positive emotions as catalysts for human flourishing and for the enchancement of systems intelligence. The proposed construct of "the upward spiral of positively catalysed systems intelligence" is intended as a contribution of particular relevance to positive psychology and positive organizational scholarship.

Introduction

Emotions are fleeting mental and physiological states, multicomponent response tendencies that open out over short time periods and contribute to a variety of personal resources (Fredrickson, 2004). In the past, emotion researchers have mainly concentrated on the negative emotions, such as fear, anger, anxiety and sadness (Seligman and Csikszentmihalyi, 2000). The negative emotions are in many ways more powerful and more attention grabbing than positive emotions (Baumeister et al., 2001) and they are often conceived as evolutionary adaptations to threats our ancestors faced. The adaptive value of negative emotions seems to be connected with their ability to spark specific action tendencies (Frijda, 1986). Critical to survival, negative emotions narrow the human's thought-action repertoires, affect specific physiology changes in the body and thus, enable the quick and decisive actions needed to adapt the current threatening situation. (Fredrickson, 2004). Positive emotions, on the other hand, are considered more diffuse (Ellsworth and Smith, 1988), fewer in the number of basic types than negative emotions (Matsmoto and Ekman, 2009) and relatively undifferentiated from each other. Moreover,

positive emotions are mainly felt in safe and satiated atmospheres (Fredrickson, 1998; 2004).

The broaden-and-build theory of positive emotions (Fredrickson, 1998; 2001) argues that positive emotions broaden momentary thought-action repertoires and help to build intellectual, physical and physiological resources for the future. In evolutionary terms this contributes to greater odds of survival and reproductive success (Fredrickson, 2003a).

Research has indicated that feelings of love, joy, enthusiasm, interest, gratitude and contentment can contribute significantly to several beneficial life outcomes, such as friendship development (Waugh and Fredrickson, 2006), marital satisfaction (Harkel and Keltner, 2001), higher incomes (Diener, 2000), better physical health (Richman et al., 2005) and remarkably even in living a longer life. According to a landmark study of the lives of 180 Catholic nuns, the nuns who expressed the most happiness, interest, love and hope in autobiographical essays written in their youth lived up to ten years longer compared to nuns who expressed the fewest positive emotions (Danner et al., 2001). Studies also show that good feelings benefit people's bodily systems in a number of ways, including speeding recovery from the cardio-vascular after effects of negative effect (Fredrickson et al, 2000), and increasing the immune function (Davidson et al., 2003). Furthermore, positivity is connected to better mental and physical health outcomes (Tugade et al., 2004, Davis, 2009) such as increased happiness (Fredrickson and Joiner, 2002) and reduced inflammatory responses to stress (Steptoe et al., 2005), and to effective team work (Losada 1999, Losada and Heaphy 2004).

On the basis of a bulk of research, it seems safe to conclude that positive emotions do contribute significantly to personal growth and development. A key point in Fredrickson's groundbreaking work is to point out that this is achieved by the broadening of the individual's habitual modes of thinking and acting which triggers building effects as a result. In other words, individuals who experience positive emotions can transform themselves, become more creative, knowledgeable, resilient, socially integrated and healthy. Furthermore, individuals are not stagnant and instead grow continually towards optimal functioning (Fredrickson, 2004).

The systems intelligence approach studies human intellect in action as it emerges in unfolding real-life environments and contexts. As an approach to human agency, the systems intelligence approach combines a holistic outlook with a localized, contextualized and positively tuned emphasis on the human potential. The systems intelligence approach follows the tradition of System Thinking (Jackson 2000; 2003; Senge 1990) in believing in adopting the concept of a system to approach holism and the phenomena of connectivity and interrelatedness (Saarinen and Hämäläinen, 2004; Hämäläinen and Saarinen, 2006; 2007a; 2008; Luoma, 2009). At the same time, the systems intelligence perspective works with a keen sense of the experiential, subjective and phenomenological dimensions of our human endowment, and with a commitment to do justice to phenomena not necessarily accountable from an objective, from-outside perspective (Hämäläinen and Saarinen, 2007b). Of particular relevance to systems intelligence are those human abilities that relate an individual to other human beings in the intersubjective realm and in forms that are nonverbal and inarticulate (Stern, 2004). It emphasises attunement to situations, contexts, other people and to the present moment (conceived of as "systems") as humanly fundamental. The commitment to talk about the human subject and systems at the same

time and as interrelated is a distinct aspect of the systems intelligence approach. It seeks to bring back that rich human endowment, that "systematicity" that research has found even in infants (Bruner, 1983; Beebe and Lahmann, 1998), which the systems thinking movement often has bypassed (Hämäläinen and Saarinen, 2008). Reaching out beyond the narrow realm of the cognitive and objective, the systems intelligence perspective connects an action-oriented systems perspective with a focus on the human sensitivities (Saarinen and Hämäläinen, 2004, Hämäläinen and Saarinen, 2008).

The aim of this paper is two-fold:

- To reconstruct Fredrickson's broaden-and-build theory of positive emotions using chemistry as a framework for illuminating generative metaphors.

- To link Fredrickson's theory with the systems intelligence perspective, and use Fredrickson's theory, as reconceptualised in this paper, in order to highlight and develop further some chief features of systems intelligence.

The result is an outline of *the upward spiral of positively catalysed systems intelligence*, a construct we believe is highly useful for positive psychology and positive organizational scholarship and for the understanding of human agency at large.

Positive Emotions as Catalysts

The broaden-and-build theory of positive emotions (Fredrickson, 1998; 2001) argues that positive emotions broaden our momentary cognitive, attentional, and motivational capacity beyond basic needs and build long-term personal resources. As empirically demonstrated (Fredrickson and Branigan, 2005), the array of thoughts and actions that come to mind is widened when positive emotions are experienced. In the studies of broaden-and-build hypothesis with 104 college students it was observed that positive emotions broadened the scope of attention, the scope of cognition as well as the scope of action compared to neutral state (Fredrickson and Branigan, 2005). These broadened thought-action repertoires can have the effect of building an individual's personal resources, including physical resources, intellectual resources, and social resources. Thus, people who experience more positivity grow psychologically and become more optimistic, more resilient, more open, more accepting and more driven by purpose (Fredrickson et al., 2003). Furthermore, they build constructive mental habits since positivity opens us to moments and thus the surroundings are more efficiently observed and appreciated (Fredrickson, 2009 p. 92). Barbara L. Fredrickson enlightened the potential significance of positive emotions as follows (Fredrickson, 2004, p. 153):

> "Positive emotions provide the fuel, creating a self sustaining system. In particular, positive emotions generate what I have called an upward spiral towards optimal functioning and enhanced emotional well being."

The concept of an upward spiral is highly appealing, and it is one of the most catchy notions of positive organizational scholarship. How should we understand this important

semi-intuitive concept? We propose to reconstruct it using concepts of catalyst chemistry, the first author's primary field of research.

Let us first determine the flourishing as living within an optimal range of human functioning, characterized by goodness, generativity, growth, and resilience (Fredrickson and Losada, 2005). In this paper, we shall assume that human flourishing can be approached in terms of thoughts, attentions and actions, i.e., whatever the details of human flourishing, it will involve thoughts, attentions and actions lived out by the subject in a way that is appropriate for the flourishing to take place.

Our first proposal based on chemical engineering vocabulary amounts to a suggestion concerning the flourishing of an individual on the theoretical level. We prose that the goal of a human life is to have *the reversible equilibrium reaction* 1 to occur as far as possible towards its equilibrium state:

$$\text{Individual} + \text{attentions, thoughts, actions} \leftrightarrow \text{flourishing individual} \qquad (1)$$

The reversible reaction means that a reaction can happen in both directions. The *chemical equilibrium* denotes the fact that there exists a condition (an equilibrium state) where the products of the reaction are formed at the same rate at which they decompose back into the reactants. Thus, the concentration of each reactant and product remains constant. At equilibrium state, the forward and back reactions occur at the same rate. Thus an individual is thought to grow in the dimensions of attentions, thoughts and actions in line with the goal to flourish. Likewise, in a reaction taking place towards flourishing, the individual is thought to be subject to attentions, thoughts and actions appropriate to growth in flourishing. In this context the *equilibrium state* of human flourishing would describe the ideal state of living at "an optimal range of human functioning, characterized by goodness, generativity, growth, and resilience" (Fredrickson and Losada, 2005).

However, it is possible in chemistry that a mixture might seem to have no tendency to change, and still it is not at its equilibrium state. This is because there exists a *kinetic barrier* which prevents the relevant change from taking place. This barrier can be approached by the concept of *an activation energy* which is needed for the reaction to occur. Sometimes this activation energy can be very high. For example, gaseous hydrogen and oxygen are virtually inert at room temperature, but react rapidly to water when exposed to platinum catalyst (Fogler, 1999).

Likewise we propose it is useful to approach the hindrances to flourishing in terms of *kinetic barriers* within us which hinder the reaction 1 to take place – the point being that the kinetic barrier can be overcome with a substance called *a catalyst*.

Although catalytic reactions were already used in antiquity, the principles of catalysis were slow to become unveiled. The term *catalysis* was introduced in 1836 by Berzelius (Hagen, 1999). Catalysts, in chemical discourse, are substances which

- increase the rate of chemical reactions
- do not have an effect on the thermodynamic equilibrium of the reaction
- do not change during the reaction (Fogler, 1999).

This means that catalysis is a cyclic process: the reactants are bound to one form of the catalyst and the products are released from another, regenerating the initial state. The intermediate reaction complexes are usually highly reactive and difficult to detect (Hagen, 1999). To illustrate the importance of catalysis, notice that most of our liquid fuels and some 80% of chemical products are manufactured with the assist of catalytical conversions (Santen et al., 1999). Chemical catalysis can be generally divided into homogeneous, heterogeneous and bio catalysis (Richardson, 1989).

Heterogeneous catalysis, which we shall use here as a metaphor, involves more than one phase, and typically the catalyst consist of *a support material* and *an active material* (e.g. a metal) (Fig 1). The active material is dispersed on *a support* material that enhances the effectiveness of the catalyst or minimises the cost of the catalyst.

Sometimes the support is a *porous structure*, upon which the active material is spread, to increase and to extend the surface area. A catalyst with a large area resulting from many *fine pores* is called *a porous catalyst*. The large surface area is beneficial in order to attain reaction rates high enough for the process to occur. Often the support and the active material interact, affecting the catalytic reaction (see the supported catalyst structure in Figs. 1, 2 and 4) (Richardson, 1989; Fogler, 1999).

Examples of heterogeneous catalysis are many, including reduction, oxidation and electrocatalytic reactions. An illustrative example is the so called three-way-catalyst, consisting of Pt and Rh metal particles supported on a ceramic monolith to control the emissions of CO, NO and hydrocarbons from automotive exhausts by the overall reactions of 2-4. This catalytic treatment of motor vehicle exhaust has been applied in all passenger cars e.g. in USA since the 1975 models (Santen et al., 2005).

$$CO+1/2O_2 \rightarrow CO_2 \quad (2)$$

$$NO+CO \rightarrow 1/2N_2+CO_2 \quad (3)$$

$$C_xH_y+3/2xO_2 \rightarrow xCO_2+y/2H_2O \quad (4)$$

One instructive way, we propose, to view the broaden-and-build theory and the upward spiral circle towards flourishing individual (reaction 1) is to envision positive emotions in terms of a heterogeneous catalysis.

We shall say that *a positive emotion catalyst* consists of the *support material* and *active materials* dispersed on it. Fredrickson, (2009, pp. 39–48) introduces ten most common positive emotions in the order of their feeling frequency: joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe and love. However, love is in many ways an exceptional emotion as it has aspects or reflections of all the other nine emotions, amounting a "many-splendored thing" (Fredrickson, 2009). Indeed love is a fundamental construct which in most of the great spiritual traditions is perceived as the ultimate source of good. The speciality of love, a transient and ever-fleeting in its essence but mesmerizing in its gravity, has inspired some of the most impressive lines civilisation has produced, such as the words of Rumi:

This is love: to fly toward a secret sky,
to cause a hundred veils to fall each moment.
First, to let go of live.
In the end, to take a step without feet;
to regard this world as invisible,
and to disregard what appears to be the self.
Heart, I said, what a gift it has been
to enter this circle of lovers,
to see beyond seeing itself,
to reach and feel within the breast.

Love, as an overreaching and arch-like fundamental emotion, we suggest, can be seen to act as *a porous support* structure, while other positive emotions, as conceived in a fredricksonian broaden-and-build spirit, are *dispersed active materials*.

In other words, we suggest that reaction 1 on the positive emotion catalyst takes place at the interface of the love *support* and the *active* positive emotion *materials*. In general, in catalysis, the more porous the support, the more extended the surface area – the more effective the support. This is because the porous structure means more channels and pores in the material which enhance its total surface area. Following this metaphor, we suggest that the more *porous* the (love) support, the more effective the catalyst. The porosity of love can be seen to demonstrate itself in the myriad forms love can operate, for instance by being patient, kind, not-envying, not-boasting, not-proud, not-rude, not-self-seeking, not-easily-angered, by rejoicing-with-the-truth, by being protecting, trustful, hopeful, and always persevering, if we dare to apply, with due respect, the immemorial characterizations of 1. Cor 13 in this context.

In general a catalyst should have the following characteristics:

- *activity* on the certain specific reactions (involving reference to a measure of how fast one or more reactions proceed in the presence of the catalyst),

- *selectivity* to catalyse only certain specific reactions (involving reference to a measure of the fraction of the starting material that is converted to the desired product) and

- *stability* against deactivation, i.e. loss of activity (involving reference to the lifetime of a catalyst in a certain process).

Since the priorities in today's industry require the efficient utilization of feedstock and energy with the lowest possible environmental impact, the relative order of importance of these functions is often considered to be selectivity > stability > activity (Hagen, 1999).

Let us illustrate these considerations using the first author's primary area of research on biomass gasification gas clean-up. Both zirconia and nickel based catalysts can remove an undesirable tar molecule from the complex mixture of the gasification product gas. In this application the removal of tar, e.g. naphthalene ($C_{1O}H_8$) and toluene (C_7H_8), is necessary in order to utilize the gas to any of its further use e.g. in energy production. However, the mechanism of these two catalysts is not the same, meaning that different reactions enable

the tar removal from the gas. In the case of zirconia the main reaction is a two step partial oxidation of tar (Eq. 5 and 6 for toluene) (Viinikainen et al., 2009; Rönkkönen et al., 2009; Juutilainen et al., 2006) whereas over Ni mainly dry and steam reforming (Eq. 7 and 8) reactions occur (Hepola, 2000; Simell, 1997):

$$C_7H_8 + 5.5\ O_2 \rightarrow 7\ CO + 4\ H_2O \quad (5)$$

$$CO + ½\ O_2 \rightarrow CO_2 \quad (6)$$

$$C_7H_8 + 7\ CO_2 \rightarrow 14\ CO + 4\ H_2O \quad (7)$$

$$C_7H_8 + 7H_2O \rightarrow 7CO + 11\ H_2 \quad (8)$$

Similarly, in the path towards flourishing, it is important to travel beyond the "one-size-fits-all terms like happy and good into precisely named emotional states" (Fredrickson, 2009). This means that diverse positive emotions as *active materials* will enable various kind of actions, thoughts, attentions to *react* with the individual. As a result, various emotions can contribute to several longterm building effects.

In heterogeneous catalysis, the reactions occur between species in different phases, e.g. gas-solid, liquid-solid, and liquid-gas. The most common of these is the gas-solid reaction, and we shall use it here for illustration. Most catalytic reactions follow the multi-stage process shown as an example in Fig 1. In this process the gaseous reactants 1) are transferred (by *mass transfer processes* such as diffusion) to the external surface of the catalyst particle and further in the catalyst pores leading to the reacting surface sites of the (e.g. metal) catalyst. Then, 2) the molecules *adsorb* on the surface of the metal because of what are known as *the attractive forces* between molecules and the metal. The reacting surface molecules are brought close enough, and 3) *the desired surface reaction* occurs. Once the reaction is over, the *reaction products* 4) are transferred (e.g. by diffusion) from the pores and from the surface and the catalyst is left unchanged. This is an ideal catalyst reaction: the rate of a reaction is increased and the catalyst is left unchanged. Thus, it can continue to participate in the same process again (Bowker, 1998; Hagen, 1999; Fogler, 1999).

Thus conceived, the positive emotions act as catalysts in the reactions between an individual and her attentions, thoughts and actions, resulting in *a temporarily broadened individual* as an intermediate result and as *an individual with building effects* in the longer run (a.k.a. flourishing individual) if the cycle is repeated. By "a temporarily broadened individual" we mean a subject that is temporarily more optimistic, more resilient, more open, more accepting, and more driven by purpose (Fredrickson, 2009, p. 91) than she tends to be before the intervention. By "individual with building effects" we mean a subject whose psychological strengths are thus affected more permanently.

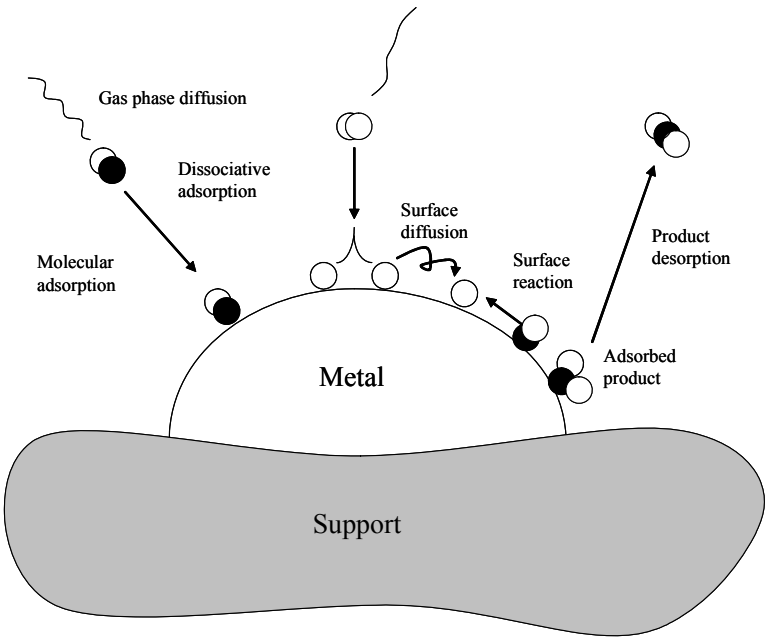


Figure 1. A heterogeneous catalytic reaction on the surface of the catalyst (Bowker, 1998).

We propose that the steps of *the catalytic system of upward spiral towards the flourishing of an individual* include both the momentary circle of broadening as well as its repeated cycles to be discussed shortly (and depicted in Fig 2). Furthermore, we suggest that systems intelligence (of self as a system) involves the ability to be mindfully (Langer, 1989) aware of the possibilities and feasibility of *the catalytic system of upward spiral towards the flourishing of an individual*.

The momentary circle of broadening is a temporary state, yet significant in its effects. People in a state of positivity have wider outlook, more ideas come to mind, more actions are viewed as possible and more creativity is experienced (Fredrickson, 2009).

We shall now pick up from a metaphorical, almost poetical description from Fredrickson in order to develop out chemistry-inspired reconstruct of the broaden-and-build theory and of Fredrickson's ideas on the upward spiral towards optimal functioning. In her landmark book *Positivity* Fredrickson writes:

> "Positivity – whether it blooms as joy, serenity, or any other hue on your positivity palette – literally gives you a new outlook on life. This, as I've mentioned, is the first core truth about positive emotions. Imagine yourself as a flower your petals drawn in tightly around your face, if you can see out at all, it is only a speck of light. You can't appreciate much of what goes on around you. Yet once you feel the warmth of the sun things change… your petals loosen and begin to stretch outward exposing your face. You see more and more. Your world literally expands. Possibilities unfold." (Fredrickson, 2009)

Setting this process in the conceptual frame of a chemical engineer yields a step by step process description or mechanism for the key reaction 1, which demonstrates how the mechanism of the reaction is different with the catalyst as opposed to without it. In general, the overall process by which heterogeneous catalytic reactions proceed can be broken down into a sequence of individual steps (as shown in Fig. 1) (Fogler, 1999). Furthermore, in order to understand and further develop and scale-up chemical processes, the mechanism and kinetics of the reactions need to be known. Representing the individual as "a flower bud", and the actions, thoughts and actions as "flower petals" the mechanism of the *summary reaction* 1 runs through the following stages:

1) *mass transfer* (diffusion) of the individual (marked as flower bud in Fig 2.) to the surface of the positive emotion from the state of neutrality or languishing ("the individual moves towards positivity and starts to feel the first signs of positive emotions"). Similarly occurs the mass transfer of attentions, thoughts and actions towards the positive emotion catalyst (marked as flower petals).

2) *adsorption* of the individual on the active site of the positive emotion. This creates an individual with an urge which is associated by positivity (in the sense in which e.g. play is associated with joy) (Fredrickson, 2004), which in turn creates *the attractive forces* for step 3 to manifest ("the individual starts to undergo the feeling of the positive emotions").

3) *dissociative adsorption* of attentions, thoughts and actions (marked as flower petals in Fig 2.) on the positive emotion because of *the attractive forces* made possible by the individual with a positively charged urge ("the individual's thoughts, attentions and actions start to get reoriented as a result of the positive emotions").

4) *surface reactions* on the positive emotion catalyst to manifest a broadened individual (marked as flower bud with the added petals in Fig 2.) ("the effects of the positive emotions upon the individual can be seen even by others").

5a) *desorption* of (the release of) the broadened individual from the surface of the active site of the positive emotion ("the individual moves on, as affected by the positive emotions to some extent and with the new thought-action repertoires they immediately give an opening for").

6a) *mass transfer* (diffusion) of the individual back to a neutral state and possibly again to the surface of a positive emotion ("the individual goes back to a neutral emotional state").

In addition to the one-time reaction path just described, the possibility of a higher-level reaction path also exists and can be described in the chemistry-inspired language for positive emotions. A higher-level reaction path follows when after step 4), instead of 5a) and 6a), the broadened individual *stays at* the stage of dissociative adsorption and thus continues to undergo the effect of the support material and of the positive emotion. The effects of the catalyst are multiplied as there is a loop from positive emotions to action-

thought repertoires which repeats the reaction process on the surface of the catalyst. In other words, in the higher-order reaction the steps are:

5b) *dissociative adsorption* of broadened attentions, thoughts and actions on the positive emotion catalyst (marked as flower stems in Fig 2.); the broadened attentions, thoughts and action keep on being affected by the positive emotion catalyst ("the individual's thoughts, attentions and actions are more deeply reoriented").

6b) *surface reactions* within the broadened individual and her broadened specific thought-action-repertoires (marked as a flower with added petals *and stems* in Fig 2.) ("the broadened individual is building several long term effects upon the individual, which can be seen also by others").

7) *desorption*, the release of the individual from the active site ("the individual moves on, and the repeated feelings of positive emotions together with the new thought-action repertoires generate enduring social, physical or intellectual building effects which become part of the individual's transformed self"

8) *mass transfer* (diffusion) of the individual with building effects (marked as a flower with added petals and stems in Fig 2.) back to the neutral state and back to the circle ("the individual goes back to the neutral emotional state and has a chance to move again towards the positive emotion").

Building on the imagery of our petals-and-stems description, we can now articulate the upward spiral towards the flourishing of an individual. It can be conceived as a life-long process where loops of the momentary circle of broadening have the possibility to *add petals* to the individual's personal blooming while similarly the parallel loops towards longterm building effects have the possibility *to create stems of* flowering.

In principle, any step (mass transfer, adsorption, surface reaction or desorption) of a chemical catalytic reaction can become the *rate limiting step*, i.e., constraint upon the process. Indeed, the rate of the whole reaction can become severely limited by a particular step. Often in chemistry this means that the overall rate of reaction is equal to the rate of the slowest step in the mechanism. For this reason, it is important to know the rate limiting step so that the rate of the reaction could be increased. When the mass transfer steps are fast compared to the reaction steps, the concentrations in the near vicinity of the active sites are indistinguishable from those in the bulk fluid and the mass transfer does not affect the rate of the reaction. However, if the reaction steps are fast compared with the mass transfer steps, then mass transfer affects the reaction rate (Fogler, 1999).

As an illustration, consider, an individual who moves by *mass transfer* processes towards positive emotion (step 1) and then *adsorbs* on the surface of the positive emotion (step 2). Then, in a state of positive emotion (such as joy) she might became an individual with an inner urge for action (in the sense in which e.g. joy can create the urge to play (Fredrickson, 2009)). When this action (play) is *adsorbed* (step 3), the individual is momentarily broadened resulting from the surface reactions (step 4 creating an *intermediate reaction product*). The broadened actions/thoughts/ attentions adsorb on the

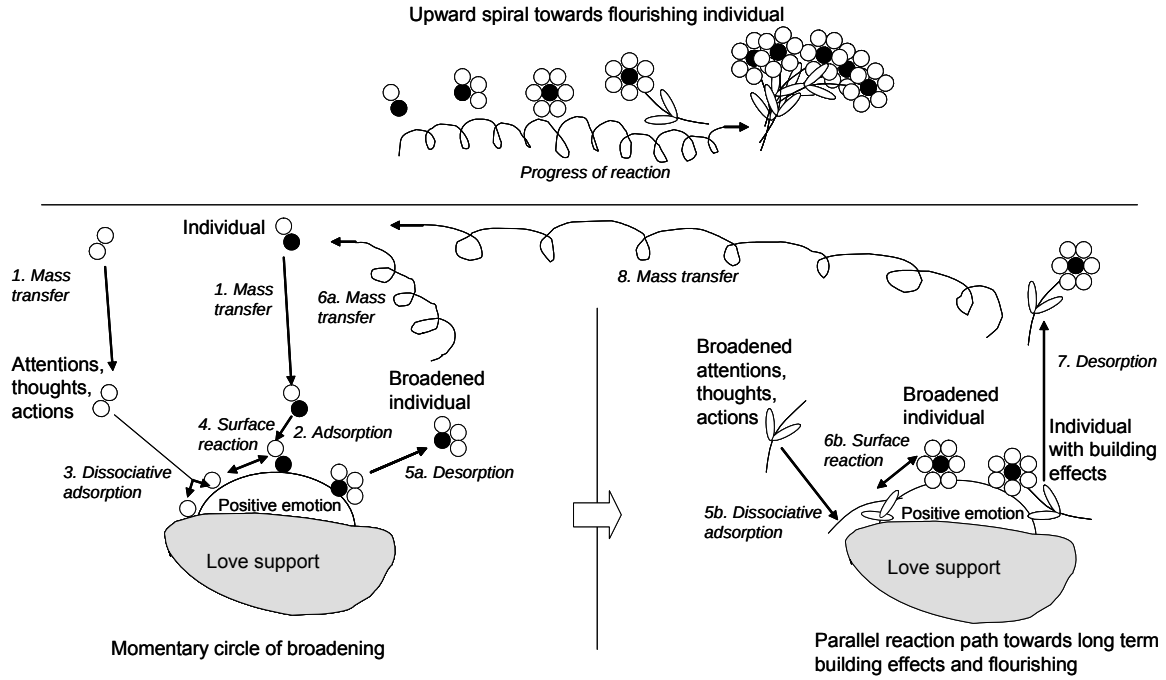
surface of the positive emotion because of the *attractive forces* between the adsorbed individual on the positive emotion and the broadened actions/thoughts/attentions. Thus broadened, the individual is brought together with more creative thoughts, attention and/or actions (e.g. to actions unrelated to play while still playing). Since the broadened effect is temporary, the broadened individual is *desorbed* from the surface of the positive emotion (step 5a) thus freeing also the positive emotion catalyst. And the individual *mass transfers* back to the neutral state (step 6a). "Just as day lilies retract when sunlight fades, so do our minds when positivity fades. Threatened with negativity, our minds constrict even further. As positivity and negativity flow through us the scope of our awareness blooms and retracts accordingly" (Fredrickson, 2009, p. 55.).

Notice, however, that at this point of the cycle, the individual can also choose to *adsorb* to the active site of a *negative* emotion, thus generating quite different reaction pathways. We can use a quotation from Fredrickson (2009, p 231) to illustrate the crucial dimension of choice of *the adsorption step*:

> "Life gives us negativity on its own. It's our job to create positivity. Positivity is a choice - a choice we all need to make again and again, day after day… Your emotions are as far from random as they are from fixed by your genes… And the more you value positivity, the more often its upward spiral will lift you to new heights… The more positivity you seed and harvest, the better become your prospects for flourishing."

However, as Fredrickson rightly points out, "there is no limit, how often our minds can cycle through these expanded and retracted awareness" (Fredrickson, 2009). Furthermore, as empirically demonstrated (Fredrickson and Joiner, 2002): "positivity and openness feed on each other each reinforcing and catalyzing each other. This is the upward spiral that the positivity triggers in you". Thus, it seems that the momentary reaction cycles of broadening can start to catalyse themselves. In other words: the momentary reaction cycles of broadening enable a *parallel reaction path* towards *reaction products* of long term building effects and flourishing (e.g. in the sense in which play can build enduring physical (Boulton and Smith, 1992) and social (Aron et al., 2000) as well as intellectual problem solving resources (Fredrickson, 2004).

These considerations suggest that *the rate limiting step* in the catalytic system of upward spiral circle towards flourishing individual might well be step 2, *the adsorption* of an individual to the surface of a positive emotion. This includes the assumption that the concentrations of the reactants (individual and attentions/thoughts/actions) in the near vicinity of the active sites of the positive emotions are indistinguishable from those in the bulk fluid and thus, the mass transfer does not affect the rate of the reaction. In other words, it might be that positivity resides at all times near us, but we need to attach or *adsorb* on its surface. This observation highlights the role of the individual herself in the process of her flourishing. In a sense, the individual is only a decisive cognitive step away from what would enhance her personal flourishing. A step, which however should be chosen "again and again, day after day" (Fredrickson, 2009). This point of course will ring familiar to anybody who approaches it from the point of view of spiritual traditions that emphasise the momentous role an individual has in her own potential transformation.



Steps in momentary circle of broadening

1. Mass transfer of individual (from the state of neutrality) and attentions/thoughts/actions to the surface of positive emotion

2. Adsorption of individual on the active site of positive emotion (individual with positively charged urge)

3. Dissociative adsorption of attentions, thoughts and actions on the positive emotion

4. Surface reaction: individual with positively charged urge and attentions, thoughts and actions react into broadened individual

5a. Desorption: broadened individual desorbs from the positive emotion freeing similarly the active site of the positive emotion

6a. Mass transfer of the broadened individual to the state of neutrality with added petals of personal flourishing

Parallel reaction path towards long term building effects and flourishing:

5b. Dissociative adsorption of broadened attentions, thoughts and actions on the positive emotion

6b. Surface reaction: broadened individual reacts with broadened specific thought-action-repertoires to make individual with building effects

7. Desorption: individual with building effects desorbs from the surface of the positive emotion complex freeing similarly the positive emotion

8. Mass transfer of the individual with building effects to the state of neutrality with added stem of the personal flourishing

Summary of the reaction: individual + attentions-actions-thoughts ↔ Broadened individual + Individual with building effects (a.k.a. flourishing individual)

Progress of the reaction: repeated loops lead to flourishing individual as several petals of flourishing are added in parallel with several stems.

Figure 2. The mechanism of the catalytic system of upward spiral circle towards flourishing of an individual.

Table 1 summarizes various positive emotions when viewed as catalysts, with paradigmatic parallel attentions, thoughts and actions to contribute to broadening and to possible long term building effects (adapted from Fredrickson, 2003b; 2009). For example, a joy catalyst on the love *support* contributes to playing and creative actions in the short run and to enduring physical, social and intellectual resources in the long run. (Free play has been shown to have crucial impact upon children's social, emotional as well as cognitive development. Free play as child is connected to better adjustment in society, better stress handling capacity and even to smartness (Wenner, 2009).)

Positive-Emotions-Catalysed-Reactions are Energetically Favourable

Why do we need the catalytic system of the upward spiral towards the flourishing of an individual and not just act rationally in a state of neutrality towards flourishing? It was suggested earlier that the reaction 1 is a *reverse equilibrium reaction*. This means that a reaction can happen in both directions and that there exists a condition where the products of the reaction are formed at the same rate at which they decompose back into the reactants. However, in everyday life we often encounter situations in which no movement towards flourishing is taking place and yet the *equilibrium state* of personal flourishing in the sense of reaction 1 has been achieved, neither. Somehow people can get stuck in their path to flourishing. This familiar phenomenon suggests that there exists a kinetic barrier within us for the reaction, meaning that a certain *activation energy* is needed for the reaction to occur. When *the kinetic barrier* is overcome, the path towards the flourishing individual "who lives within an optimal range of human functioning, characterized by goodness, generativity, growth, and resilience" (Fredrickson and Losada, 2005) is made possible. Furthermore, in *the reverse reaction*, the possibility emerges in which the flourishing individual will provide the appropriate thoughts, attentions and actions in line with a drive for human flourishing. In other words, the significance of catalysis as a process is enormous, if one can make it happen.

The magnitude of the significance of catalysis, when it takes place, is a point we cannot overstate. Recall what Santen et al (1999) point out in the preface of their book *Catalysis: An Integrated Approach*:

> "Chemical reactions, for which one would expect half-life times as long as centuries, can be accomplished in minutes to hours with the magic power of a mysterious black box containing a catalyst."

This point perhaps illustrates the striking power of positive emotions as triggers of change.

We shall now turn to another important aspect of our analysis of positive emotions as informed by the chemistry metaphors – the concept of energy.

Table 1. Positive emotions as catalysts to broaden-and-build an individual towards optimal functioning (adapted from Fredrickson, 2003a;b; 2009).

Catalyst	Features	Attention, thoughts, actions to contribute broadening	Long term building effects
Joy	Feeling playful, bright, light, spring in the steps, inner glow	Play, pushing limits, being creative	Enduring physical, social stress handling, intellectual resources
Pride	Upright posture, slight smile	Sharing news from achievement with others, envisioning of new achievements in future	Fuels self-esteem, and achievement motivation
Interest	Sense of possibility or mystery, fascination, feeling open and alive	Exploring, taking in new information and experiences, expanding the self, learning more	Knowledge and intellectual complexity
Content-ment	Feeling that everything is right as it is	Savouring current life circumstances, integration of the circumstances into new view of self and world	Produces self-insight and alters worldviews
Gratitude	Feeling of appreciation of something that has come to our way	Creative and wide array of actions to promote the well being of other people	Builds and strengthens social bonds and friendships, builds social resources, motivates permanent faithfulness and spiritual growth
Love	Contains and overlaps all the other positive feelings	Exploring, savouring, and enjoying people and life at large	Inspired and uplifted interactions to build and strengthen social bonds and attachments

In chemistry, *bonds* have to be weakened in order to allow for the change of one substance into another, and this involves the input of *energy*. To increase the rate of a reaction you need to increase the number of *successful collisions* of the reacting particles. Collisions only result in a reaction if the particles collide with enough energy to get the reaction started. This minimum energy required is called the *activation energy* (Fig. 3). Remarkably, a catalyst provides an alternative route for the reaction. *That alternative route has a lower activation energy resulting in an increase of the reaction rate*. We believe this point is absolutely vital to appreciate, and a strong indication of the usefulness of the chemistry metaphor in the connection of the study of positive emotions and flourishing.

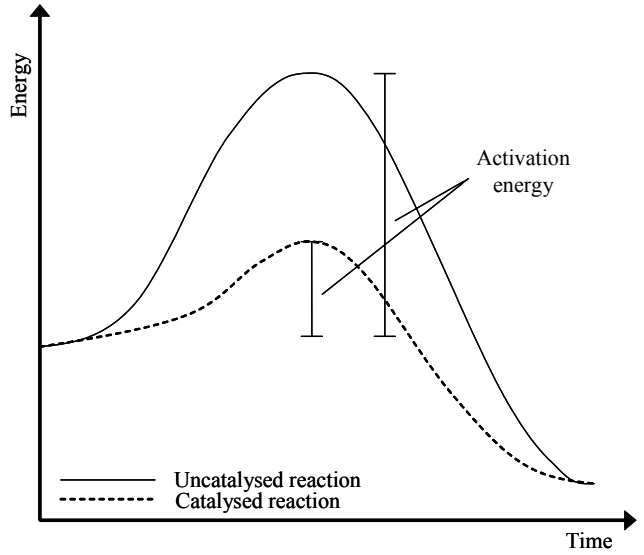


Figure 3: Generic graph showing the effect of a catalyst in a hypothetical exothermic chemical reaction. Uncatalysed reaction is shown with the upper line and catalysed reaction with the lower line in the graph.

As in any catalytic process, the positive emotions catalysts are ideally not consumed or changed during the process but only facilitate the kinetic effect of cognitive broadening and self growth. This means that the potential of an individual to react according to the reaction 1 is significantly accelerated on top of a platform of positive emotions as compared to a situation without them (non-catalysed conditions). The non-catalysed conditions would mean actions, attentions and thoughts in a state of emotional neutrality (perhaps through emotionally neutral rational thinking) towards flourishing individual.

Furthermore, this change in the rate of reaction, vital for catalysed reactions and for the functioning of positive emotions as reconstructed here, is made possible because the mechanism of the reaction is sharply different when the catalyst is involved and when it is not involved. The path to the goal of flourishing with positive emotions is energetically favourable compared to the path without positive emotions.

Why is *the activation energy* and *the kinetic barrier* within us lowered by positivity? Energy is a semi-intuitive concept often alluded to in human sciences, organizational research and their applications. Differentiated from the physical concept of energy, energy in human contexts can be approached in a number of ways but here we find it useful to view it as "a type of positive affective arousal, which people can experience as emotions – short responses to specific events – or mood – longer-lasting affective states that need not to be a response to a specific event" (Cross et al., 2003). Since energy is a reinforcing experience, people attempt to enhance, prolong, or repeat the conditions they perceive to be increasing it. Likewise, people try to diminish or avoid the circumstances that are perceived as decreasing their energy (Collins, 1993). Furthermore, since energy is a positive affect,

people who feel high levels of energy have a tendency to view events positively and to expect positive events to occur (Arkes et al., 1988).

It has been suggested that the energy for human actions comes from four main wellsprings: body, emotions, mind and spirit. Positive emotions contribute to the quality of energy; when people are in a state of positive energy, they perform as their best (Schwartz and McCarthy, 2007). Fredrickson observes in her book (2009, p. 226) that based on her 20 years of studies on positive emotions, positive experiences outnumber negative experiences in their relative frequency by about 2 to 1 with most people. At the rate of 2-1, life is not particularly distinctive. When the ratio is raised to 3 to 1, a major transformation occurs, "you have stepped up to a whole new level of life". The ratio of 3-1 is the tipping point of flourishing, Fredrickson suggests. Many researchers believe that at the fundamental level, positivity alters the brain and affects the way the individual interacts with the world (Ashby et al., 1999). This is where the catalysis starts to take place.

Positive Emotions as Catalysts Towards Systems Intelligence

The research of Fredrickson and her associates have demonstrated that people who experience positive emotions take more easily a "big-picture" view, attending to the general outline of images rather than to the details (Fredrickson and Branigan, 2005). They are more open to new information, are more creative as more ideas and thoughts come into their mind. Research suggests that positivity enhances broader flexible cognitive organisation and ability to integrate diverse material (Isen, 1990). With positive emotions, the scope of the attention is widened (Fredrickson and Branigan, 2005).

These key features of positive emotions are vital for systems intelligence. As is customary within the systems thinking movement, the systems intelligence approach wants to find ways to articulate the human strive towards the big picture as opposed to the details. Anything that enhances the subject's abilities to see the forest for the trees is welcome news for systems intelligence. Some of that is bound to be related to the subject's cognitive realm, but not all, as a subject might well approach a whole in the sense in which a conductor in the living and emerging presence of the performance of a symphony. Many of the skills that are called upon in *that kind of extended grasping of wholes* are likely to be emotion-related – and are part and parcel of a fredricksonian broaden-and-build process.

Indeed, anything that increases an individual's skills to adapt successfully to wholes and to conduct productively "processes of systems thinking" (using the apt phrase of Luoma, 2009), is welcomed by systems intelligence. Many of the parameters to be encountered are likely to have a strong subjective and intersubjective twist to them, as opposed to the positivistic objective. This introduces a powerful playing ground for positive emotions. From the point of view of systems theorizing, as well as the understanding of emotions, we believe this point is critical to appreciate. It is vital to bring the research on emotions and the research on systems to bear on one another. (On this theme, see also Hämäläinen and Saarinen, 2008 and Luoma et al., 2008.)

Many forms of systems thinking tend to emphasise the objective and explicit forms of knowledge, with the idea of describing systems from outside as objective phenomena. This is fine in many contexts, but typically will amount to disregarding emotions along with other subjective phenomena. Yet it seems obvious that emotions are particularly relevant

for humans precisely because they allow the subject to sense the environment and the situation, other human beings and their intentions etc., more holistically and acutely. The subject can adapt more successfully, because she senses a possibility in the air, or a threat around the corner, even when she cannot tell what it is. More generally, as pointed out in the systems intelligence literature, many key aspects of the functioning of the systems with respect to which the subject is systems intelligent might not be *cognitively accessible* to the agent in question. In order for an agent to act systems intelligently in a system she need not know the system in its objective characteristics and might not be in a position to represent or describe the system for others. As Hämäläinen and Saarinen (2004, 2008) emphasize, for an agent to act intelligently with a system it may be enough for a human to have a "feel" of the system. Indeed, such a feel of a system might well be forthcoming well before any rational understanding of it, a point reinformed by infant research. In all of this emotions loom large. We venture to suggest that a key way in which positive emotions "broaden-and-build" is by extending the individual's ability to *feel systems*, be they contexts, situations, the intentions of other people, or oneself as a whole, etc. Positive emotions broaden-and-build the sensitivities with which humans *tune to their systemic environments* and thus broaden-and-build the individual's capabilities to adopt and to thrive.

We are suggesting that positive emotions not only expand the cognitive mindscape of human subjects but also – and importantly – their *systemic interface* with their environments. Positive emotions bring new possibilities into the individual's scope of orientation and realm of sensibilities, thus enabling a wider feel of systems and more intelligent actions within those systems. This is remarkable indeed, as all action can be conceived as taking place within systems (environments, contexts, etc). Not only do positive emotions broaden-and-build the individual's long term capabilities but also her immediate skills of adapting and succeeding with the systems at hand.

An important aspect of such an extended feel of systems relates to the individual's ability to link with other people. That capacity has been demonstrated to be enhanced by positive emotions. For instance, positive emotions enable people to find more varied and adaptive ways to use their social support network (Cohn and Fredrickson, 2006).

These observations are reinforced by the fact that positive emotions increase individuals' use of adaptive reframing and perspective-taking coping skills (Fredrickson and Joiner, 2002). As a result, positive emotions offer a support structure for the cognitive aspects of an individual's system intelligence as it operates: "The tools to higher awareness via systems intelligence include the reframing and rethinking of own thinking regarding the environment and feedback structures and other systems structures of that environment. " (Saarinen and Hämäläinen, 2004)

As C. West Churchman once put it, systems approach starts when you perceive the world through the eyes of another person (Churchman, 1968). Churman's point is largely cognitive in nature, but it can be interpreted more widely. According to empirical studies by Fredrickson and her colleagues, positive emotions broaden the sense of self in connection to others and thus make people feel a self-other overlap more easily as well as "oneness" with the people close to themselves and with people in groups. Positivity shifts from the "me" view to more overlapping view of the "we". (Waugh and Fredrickson, 2006). As a result, the individual understands herself easier as a part of the whole, the influence of the

whole upon herself and the influence of herself upon the whole, all chief aspects of systems intelligence (Saarinen and Hämäläinen, 2004).

Systems intelligence amounts to intelligent actions in the context of complex systems involving interaction and feedback (Saarinen and Hämäläinen, 2004). One potential obstacle here is created by various forms of separateness and non-connectivity with other people. But positivity has been shown to act as a counterdose to disconnectivity. For instance, positive emotions facilitate changes from divisive group attitudes into inclusive group identities (Fredrickson, 2009 p. 69). Indeed, positivity helps individuals to stay open and alter the view towards strangers. Remarkably, people under positivity recognize people of different races in ways more similar to their own race, meaning that we are able to see the person behind the racial label. Positive emotions thus help to avoid the trap where all the Chinese look similar in the eyes of Europeans and vice versa (Johnson and Fredrickson, 2005). It is easier to be systems intelligent with the help of positive emotions because you more easily link with other people emotionally and cognitively.

The long list of systems intelligence relevant inducements of the broadening effects of positive emotions include:

- Creative and optimal solutions to everyday problems become easier (Fredrickson and Joiner, 2002).

- Marital satisfaction is highly correlated to the level of feeling self-other overlap between the couple (Aron, 1992).

- Relationships in general are closer, longlasting, attracting loyalty instead of bitterness (Fredrickson, 2009)

- Broadening builds "both strategic alliances and globe-spanning friendships" (Fredrickson, 2009).

- Managers with greater positivity are more accurate and careful in making their decisions and more effective interpersonally, they infect it to the group members making a better coordination among team members and reducing the effort needed to get their job done (Sy et al., 2005; Staw and Barsade, 1993).

- People who come to the bargaining table with a cooperative and friendly spirit – "riding on positivity" – (Fredrickson, 2009), in contrast to negative or neutral emotions, are more likely to incorporate a future business relationship in the negotiated contract (Kopelman et al., 2006).

- Organizational groups tend to start working on "we" principle towards common goal (Fredrickson, 2009)

It is natural for people to desire improvement and a change for the better. As observed in the change literature, often a major change can result as a consequence of a minor initial move and with minimal conscious effort (Saarinen and Hämäläinen, 2004). What is the role

of positive emotions in bringing about major output with minor input? We believe a paradigmatic type of major-change-through-minor-impact is one where a small initial change enhances the positive emotions of the participants, in many cases highly irrationally and beyond the objective facts, with the result that *the catalysis described above starts to unfold*. (Such logic is clearly at work in "the emergence and amplification of small change" analysed by Plowman et al., 2007.)

Based on the above examples which do not intend to be comprehensive, positive emotions seem to fuel and broaden the individual and open the way for the person for Systems Intelligent actions and behaviours. The proposal here is that positive emotions are *catalysts* for Systems Intelligent behaviours and actions. In this view the momentary reaction circles of broadening produce a momentary Systems Intelligent observer (analogously to the broadened individual of Fig. 2).

Systems intelligence aims to identify the visible and invisible parts of environment conceived of as a system and to work with those systems productively (Saarinen and Hämäläinen, 2004). Systems intelligence often involves a "thinking of thinking" process where the person re-thinks his own thinking. The role of mental models and other mindset-related matters in human affairs and actions is generally acknowledged (see e.g. Senge, 1990). The vital role of emotions is less often paid attention to, while there is little doubt of its significance for our decisions making processes and modes of operating (Frijda, 1988) Even less focus is directed on the fact that humans are systems, i.e. wholes the structure of which cannot be reduced to the functionings of its parts. To be a human being is to be a complete human being and one intertwined with "strange loops" (Hofstadter 2007).

Thus, it can be conceived that the catalytical system of Fig. 2. might start to produce a self-sustaining positive loop with Systems Intelligent building effects. A remarkable outcome of the catalytic system described in Fig. 2 would be an individual with Systems Intelligent building effects. The catalytic system of Fig. 2. would amount to *the upward spiral of positively catalysed systems intelligence*.

Bad is Stronger than Good and Systems Intelligence is Even Stronger

One aspect of the life of a chemist is that while ideally catalysts should last forever, in actual reality they *get damaged*. Use wears them out, with the result of *deactivation*, i.e., the loss of activity of the catalyst. The causes of deactivation are basically three-fold: chemical, mechanical and thermal. The mechanisms of the deactivation can be grouped into six: (i) poisoning, (ii) fouling, (iii) thermal degradation, (iv) vapour compound formation accompanied by transport, (v) vapour–solid and/or solid–solid reactions, and (vi) attrition/ crushing. The groups (i), (iv), and (v) are chemical in nature while (ii) and (vi) are mechanical (Bartholomew, 2001).

Positive and negative emotions cannot fully coexist, since the thought-action repertoire cannot be broad and narrow at the same time (Fredrickson, 2004). From an evolutionary perspective, survival and reproduction depend on giving priority to avoiding bad rather than pursuing good (Baumeister et al., 2001, p 360), thus suggesting that the negative emotions have more power compared to positive emotions (Baumeister et al., 2001). However, according to Maslow's motivational theories, the positive feelings begin to direct behaviour when the deficiency motives such as hunger, deprivation and danger are satisfied (Maslow,

1968), and much of Fredrickson's work amounts to unveiling the evolutionary and motivational significance of positive emotions. It is indeed clear that both negative as well as positive emotions are evolutionarily crucial; negative emotions as narrowing the thought-action repertoires in order to react to an immediate threatening situation and positive emotions for the benefit of growth and optimal functioning.

In our lives in contemporary technological consumer societies, even if natural threats are rare in everyday life, our inbuilt and evolutional *tendency to focus upon the minimizing of bad* is still strongly functioning within us as a gift of evolution. Using again the chemistry inspired metaphors of the discussion above, one could say that to the extent that "bad is stronger than good", we have a tendency to close our petals from light and to close ourselves in *nonporous* negativity (Fig. 4). In catalytic terms this can be described as the *sintering* of the *support* of the positive emotion catalyst, which amounts to reducing the *surface area* of the (love) *support* where the positive emotions could *adsorb*. This is analogous to the case where chemical catalysts sinter, lose their porous structure, thus leaving less active space for the reactions because of prolonged exposure e.g. to high gas phase temperatures (Richardson, 1989).

Another usual deactivation mechanism is *coke formation* (Fig 5A) where carbon may get chemisorbed strongly as a monolayer or physically adsorb in multilayers and in either case block access of reactants to metal surface sites, or totally encapsulate a metal particle and thus completely deactivate that particle, and plug pores such that the access of reactants is denied inside these pores (Bartholomew, 2001). The concept of *coke formation*, we propose, is quite suggestive as a metaphor for the understanding of the obstacles to positive emotions. Negative emotions, especially fear, can be seen as responsible for the *coking* effects on positivity. Fear bonds with *an active site* as well as with the love *support* of the positive catalyst to block the catalytic function.

Another usual deactivation mechanism is *poisoning* (Fig. 5B). Poisoning takes place as the strong chemisorption of reactants, products or impurities on the active sites which are otherwise available for catalysis (Bartholomew, 2001). As in the case of Fig. 5B, sulphur (S) has adsorbed on the metal, thus blocking the activity of this particular metal site.

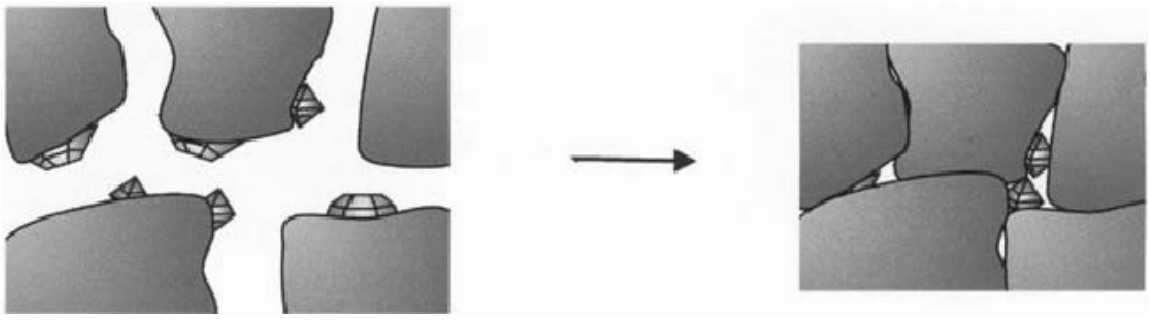


Figure 4. Deactivation mechanism by sintering (Lassi, 2003). The active metals which potentially could serve as catalysts are marked as "diamond structures" on the porous support material.

The limitations to the growth of systems intelligence as described by Saarinen and Hämäläinen (2004, p. 69) include: reactionary mindset, static, mechanical improvement command- and control kind of and no-growth modes of thinking, elementalism, individualism, and cynism. These negative tendencies do seem to function like the catalyst *poisons* depositing on the positive emotion catalyst by the time on stream and thus limiting the surface area for the reactions of *the upward spiral of positively catalysed systems intelligence*.

From the point of view of chemistry, coking is a particularly serious phenomenon. The significance of coking is described powerfully by Bartholomew (2001):

> "Finally, in extreme cases, strong carbon filaments may build-up in pores to the extent that they stress and fracture the support material, ultimately causing disintegration of catalyst pellets and plugging of reactor voids"

Likewise, when seriously *coked* by negativity the love *support* of the positive emotion catalyst would not have *porosity* or space for activity and in extreme case could lead to disintegration and self-plugging. It could be further thought that if love is the support material for *the upward spiral of positively catalysed systems intelligence*, then the support material for the *systems of holding back* (Saarinen and Hämäläinen, 2004, Hämäläinen and Saarinen, 2007a, 2008) might be fear as *deposited* as *coke* on the original love *support*.

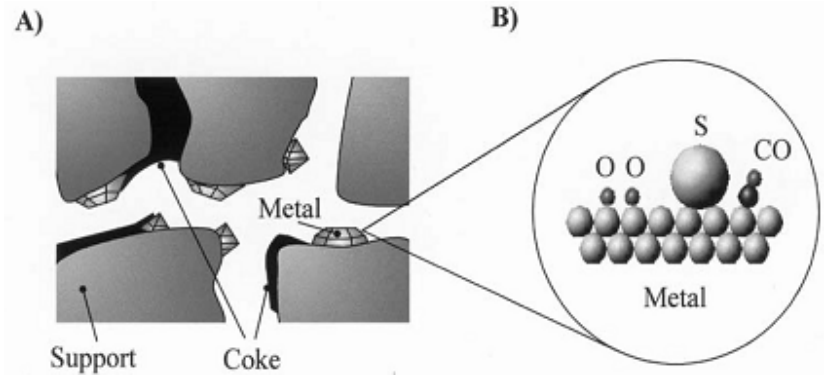


Figure 5. Deactivation mechanisms by A) Coke formation, B) Poisoning (Lassi, 2003).

Luckily, it is also possible to *regenerate* a catalyst. For example, coke depositions can be burned in the air and thereby the catalyst activity can be regained. Similarly, one could envision ways to regenerate the activity of a love *support*. It is indeed inspiring to think of fear as coke to be burned with the flames and air of positivity to reveal the original *support* in its purity. Likewise one could study means to minimise the *sintering* phenomena. One might be tempted here to speculate with the possibility of stepping beyond the current *system of minimizing of bad* and towards *the evolution of positive mindfulness*. In the latter, we would increase the degree of mindfulness of our positive systemic endowment, and be particularly mindful to fight the catalytic *coke* of negativity as well as the *poisoning* of the love support, thus paving the way for flourishing.

In most approaches to human growth reframing and rethinking of one's own thinking looms large. Human beings can observe their thinking and the effects of that thinking on what follows. There is the possibility to become more acutely aware of flourishing-generating modes of thinking as well as of the accompanying practices. Remarkably, according to recent research, randomly chosen working adults who were assigned to practise loving-kindness meditation, increased the daily experiences of positive emotions, which further increased wide range of personal resources such as increased mindfulness, purpose in life, social support and decreased illness symptoms (Fredrickson et al., 2008). Moreover, Fredrickson offers an impressive toolbox for both decreasing negativity and increasing positivity in her book *Positivity*. In our framework, reducing negativity means cutting down the *poisoning* and *coking* agents for the catalyst activity. The techniques that Fredrickson (2009) suggests seem appropriate here (disputing negative thinking, breaking the grips of rumination, becoming more mindful with the use of meditation techniques, assessing media diets, finding substitutes for gossip and sarcasm and learning to deal with negative people with different techniques). We encounter here efficient ways to increase the positivity ratio, through the cycles of Fig. 2.

How could we speed up the overall reaction 1 in line with our process description in Fig. 2? We have suggested that the rate limiting step of the whole process might well be the *adsorption* on the positive emotion catalyst. Fredrickson's list of techniques for increasing positivity could be interpreted as a toolkit for increasing the *adsorption* on the surface of the positive emotion. The relevant techniques include: finding positive meaning in situations, savouring goodness, being kind to others, following your own passions, dreaming of the future, connecting with nature and others, applying your strengths in every day situations and open your mind and heart via meditation practices (Fredrickson, 2009). It is worth noticing the strong presence of life-skill-like and accessible-to-all elements in Fredrickson's list. The tools relate to the fundamentals of what it means to be human, as opposed to being formally trained or being strong in academic competencies. Objective knowledge does not dominate. Here one is reminded of a key emphasis of the systems intelligence approach in its desire to do justice to those aspects of human situational action capabilities that point beyond what can be known or grasped in objective terms. Laugher and humour, two channels of everyday systems intelligence, bear a family resemblance to Fredrickson's list. "Systems intelligence is about compassion and love that makes good pragmatic sense" (Saarinen and Hämäläinen 2004 p. 68).

As already suggested, Fredrickson's theory of positive emotions can be seen as an articulation of the catalytic nature of positive emotions towards human flourishing. The systems intelligence perspective is a theory of the positively tuned, situational, action-based, whole-and-system-oriented, sensibilities based nature of the human condition. As such, it is natural to assume that the systems intelligence perspective builds upon the functionings of the human catalysts for human growth and flourishing whatever they might be. Those catalysts, to the extent they exist and operate via positive emotions, are likely to be only partially accessible to introspection and available to the subject's objective grasp. What is the nature of the skill set of a subject who is able to use positive emotions as a broaden-and-build reservoir in her catalytic processes towards growth? Nothing overtly reliant on system 2 of Stanovich and West (2000) only, we suggest!

Instead, the intelligence that carries the subject day in and day out, indeed since early infancy, will involve rich reliance of sensibilities, intuitions, subjective factors and intersubjectivity skills that positivistically oriented scholars have typically bypassed and dismissed. It is those aspects of the human endowment that the systems intelligence theorists have time and again highlighted. As we have tried to suggest in this paper, that systemic endowment assigns a key role for positive emotions. Positive emotions broaden-and-build human flourishing in the dimension of systems intelligence.

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