



A dynamic systems approach to the feeling-toned complex

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Abstract: A review of Jung's writing on the 'feeling-toned complex' shows that he considered it to comprise independent, split-off, psychic elements. Modern advances in scientific thinking and technology, namely Dynamic Systems Theory and neuro-imaging, allow us to better define and explore this psychic phenomenon. Considering the constellation of the complex as a hierarchy of dynamic systems allows for a prediction of the timing of brain activity. This has been confirmed by two independent studies using fMRI and QEEG while administering the Word Association Experiment, the tool Jung used to investigate brain/psychic functioning over a century ago. Using as a framework the stages of the constellation of a complex viewed as a hierarchy of dynamic systems, I review the neuro-imaging studies reported by Petchkovsky et al. (2013, 2017) and Escamilla et al. (2018), concluding that quantitative theoretical predictions and experimental results are in agreement within an order of magnitude. The change in attention caused by the constellation of the complex can also be conceived as the switching from a default neuro-network, a startle response activating executive functioning in the frontal cortex of either the ego-complex or an autonomous complex.

Keywords: archetype, complex, dynamic system, fMRI, QEEG, splinter psyche, WAE, Word Association

Introduction

In his early work with the feeling-toned complex, Jung was interested in proving that the mind is not something unrelated to the body. His experimenting with the galvanometer shows this. It must have been beyond his imagination that we would ever be able to actually have images of the brain during the activation of a complex, proving that words are connected to bodily reactions. They are not simply a phenomenon of the mind: complexes and their meaning in the context of one's life are registered in the body.

This article strives to show the overlap in Jung's concepts of the feeling-toned complex and the archetype, as presented in his writing, with current scientific thought and technical advances, namely Dynamic Systems Theory, neuro-

imaging studies (fMRI and QEEG) and the mapping of changes in emotional states to regions in the brain. Mirror neurons are also considered with reference to self (myself) and 'other'.

Jung's writing on the complex

Jung's writing on the complex falls into three time periods: first his early work with Eugene Bleuler at the Burghölzli Clinic in Zürich until his break with Freud, which led to the period when he more or less stopped public work while working on the *Red Book*. Second, the period from when he started publishing again from about 1921 until the publication of 'A Review of Complex Theory' in 1934 and the 'Tavistock Lectures' in 1935. Finally, in his later writing he continued to refer to complexes frequently.

Early work with Bleuler and on the Word Association Experiment

Jung's original work with the Word Association Experiment [WAE] (circa 1902-1912) established his reputation as a researcher in experimental psychology. His theory of complexes grew directly out of this research initiated by Bleuler and carried out together with Riklin and others at the Burghölzli. Their aim was to identify how the mind works in both normal individuals and in cases of severe mental illness. Imagine yourself back at the beginning of the twentieth century, when there was no classification of mental illness, no agreed definitions of psychosis, neurosis or personality disorders, and no DSM or ICD summarizing diagnostic criteria. It must have been an exciting time trying to find the causes for what no one could explain. The cause that Jung identified was the feeling-toned complex. Although influenced by the work of others, how he defined it was his own. He credits the work of Bleuler on schizophrenia (Jung 1907a), the ideas of Pierre Janet around splinter psyches (Janet 1894) and Freud's work on repression of the symptom in neurosis (Jung 1907b, para. 922). Although the term 'feeling-toned complex' had been used by others before him (Theodor Ziehen 1898), his interpretation and link with the word association, was his own (Jung 1973, p. 210).

Jung's major works on the word association experiment were published between 1904 and 1911. It was conducted with both normal people and neurotic/psychotic patients in the clinic. He noted the more destructive element of the complex in schizophrenic patients due to the extreme *abaissement du niveau mental*, which was an important element in his theories at the time. He posited that the split in schizophrenics is organic in nature, perhaps due to 'affect-toxins' (Jung 1907a, para. 76), and is total. Each complex then lives an existence of its own, with no personality left to tie

them together (Jung 1935, para. 382). In ‘neurotic’ and ‘normal’ individuals, the complex has more conscious attributes (Jung 1939, paras. 508-9).

He identifies the complex as the determining factor of the form taken in symbol formation (Jung 1907b, para. 922). This is evident in the choice of the word given in reply during the word association experiment; the complex, if present, will colour the choice of the response. Towards the end of this period there appears a review and a differentiation of his ideas in relation to the work of Freud (Jung 1912 revised 1955). He clearly links the complex to dreams (Jung 1906), and fantasies (Jung 1912/1955, paras. 404-6). During this period Jung used the Freudian terms Oedipus Complex, Electra Complex, Power Complex (for Adler’s Inferiority Complex), etc. Later he used Mother, Father, Sibling, Child, Incest, Power, etc. (which, however, he referred to as ‘hackneyed’ [1956, para. 1257]).

A clear definition he gave at this early period was in a paper written for a conference of the Australian Medical Association in September 1911, and published as part of the papers of the congress in 1913: ‘Riklin and myself have introduced ... the term *complex*, because ... (it) is always a collection of various ideas, held together by an emotional tone common to all’ (Jung 1911/1913, para. 1351). Hence a complex is simply all of the memories around a specific emotion, or combination of emotions. A shorthand expression for this is:

$$Cx = (E + M) * R^1$$

Split-off autonomous groups of associations

Jung described complexes as ‘autonomous groups of associations that have a tendency to move by themselves, to live their own life apart from our intentions’ (Jung 1935, para. 151). He referred to them as ‘split-off’ psychic components, particularly in these early works (Jung 1902, paras. 97, 98, 133; 1907a, paras. 59, 71, 299, 304, 313). It also runs throughout his writing with relation to complexes (Jung 1922, para. 115; 1931a, para. 134; 1935, para. 151; 1945/54, para. 465; 1953, paras. 832-3). This is the reason for his use of the term ‘autonomous complex’. In the 1934 article ‘A review of the Complex Theory’ he wrote:

... for fundamentally, there is no difference in principle between a fragmentary personality and a complex.... Today, we can take it as moderately certain that complexes are in fact ‘splinter psyches’. The aetiology of their origin is frequently a so-called trauma, an emotional shock or some such thing, that splits off a bit of the psyche.

(Jung 1934, paras. 203-4)

¹ Complex = (Emotion + Memories) which occurs Repeatedly (times R). I thank a webinar student, whose name I do not know, who added *R to my original Cx=E+M.

He referred to split-off psychic complexes as the cause of neurosis (Jung 1928a, para. 48; 1935 paras. 382-3) and psychosis (Jung 1939, paras. 508-9), and differentiated between the two based on the degree with which they are incompatible with the ego (Jung 1948, para. 1155; 1953, para. 832). He repeatedly referred to the cut-off nature of the complex as the basis for its appearance as demonic or as a spirit (Jung 1921, paras. 174-6; 1928/1931 para. 712; 1934 para. 204; 1945 para. 419).

Refining the definition 1921-1935

Although his work with the word association experiment stopped when he left teaching at the university, there was further development and refinement of Jung's theories in his publications when he started publishing after the period of his work on the *Red Book*. He identified the cause of the complex as being trauma (Jung 1928b, paras. 262-276) and as 'shock, upheaval, mental agony, ... "Skeletons in the cupboard"' (Jung 1931b, para. 924).

In 1934 Jung published 'A review of Complex Theory', which is the work he most often cites in later writing when referring to complexes. In it he refers back to his work with the word association, viewing complexes not as a theory he invented but as a fact that he discovered empirically (Jung 1934, paras. 196-7). Defining the complex, he wrote:

What then, scientifically speaking, is a 'feeling-toned complex'? It is the *image* of a certain psychic situation which is strongly accentuated emotionally and is, moreover, incompatible with the habitual attitude of consciousness (that is to say incompatible with the normal position of the ego). This image has a powerful inner coherence, it has its own wholeness and, in addition, a relatively high degree of autonomy, so that it is subject to the control of the conscious mind to only a limited extent, and therefore behaves like an animated foreign body in the sphere of consciousness.

(Jung 1934, para. 201)

In 1935 Jung gave a series of five lectures and discussions to members of the medical profession at the Tavistock Clinic in London. In the first three of these lectures he dealt quite extensively with the complex: Lecture 1: The ego as complex (Jung 1935, paras. 18ff), Lecture 2: The autonomous complex and the word association experiment (*ibid.* paras. 99ff) and Lecture 3: The theory of complexes (*ibid.* paras. 148ff). In these lectures he again stressed their split-off, independent nature (*ibid.* para. 151) and their expression as neurotic symptoms (*ibid.* paras. 382-3). He makes the interesting comment that it is not the fact that a person has a complex that is important, we all have complexes, 'It is only interesting to know what people do with their complexes; that is the practical question which matters' (*ibid.* para. 175).

Continued reference to complexes including archetype as instinct

Jung subsequently repeated and developed the ideas of complexes as split-off parts of the psyche and of their demonic character (Jung 1945 and 1948 throughout but in particular para. 597; 1947/1954, para. 383). The ego-complex is related to consciousness (Jung 1921/1971, para. 700), but the autonomous complexes have ‘a certain luminosity of their own’ (Jung 1955, para. 47). He suggested that, perhaps because of this luminosity/numinosity, we see them in projection and particularly in the transference (Jung 1946a, para. 438; 1955, para. 486).

One new factor which seems to appear in his writing after 1935 is the connection of complexes with the archetypes, specifically as defined in relation to instinct. Jung defined archetypes in many ways throughout his work. The definition most related to both the body and to contemporary neuroscientific investigation is the bipolar nature of the archetype as instinct and archetypal image. This is most clearly stated in Jung’s monograph on synchronicity with reference to the constellation of a complex: ‘The conscious then comes under the influence of unconscious *instinctual* impulses and contents. These are as a rule complexes whose ultimate basis is the archetype, the ‘*instinctual pattern*.’ (Jung 1952a, para. 856, emphasis added). Later, Jung wrote ‘Because of its instinctual nature, the archetype underlies the feeling-toned complexes and shares their autonomy.’ (Jung 1958b, para. 847). The instinctive nature of the archetypes is also mentioned in several other articles (Jung 1917/1943, para. 111; 1956, para. 1257-8; 1958a, para. 755).

Constellation of the feeling-toned complex as a hierarchy of dynamic systems

Remember the last time you ‘fell into a complex’. You see, hear, or feel something which suddenly grabs all of your attention (*perception*). You experience a wave of very strong *instinctive emotion* that sweeps through your body. This emotion alters your *level of awareness*; either you are completely on guard, watching for every movement, waiting to hear the next word being said, or you are in a fog, walled off, dissociated from all that is happening around you. Your heart is pounding, maybe your breathing pauses so that you can better hear what is being said (*bodily reaction*). In the worst of cases, it feels as if your whole life depends on what is happening (*meaning*). You may take on a role (*archetypal image*) such as the Warrior, the Avenger, the Wounded Child. Afterwards, if you are honest with yourself, you admit that it is ‘always’ like this, every time you are in a similar situation, you always react the same way. ‘Always’ is a sure indicator of a complex.

Looking more closely at each of these steps with relation to time scales and what is happening in the brain and body, they can be conceived as forming a hierarchy of dynamic systems (Krieger 2014). The first level involves the triggering perception, what you saw, heard, or felt that set off the

constellation of the complex and the almost instinctive reaction to this with its accompanying emotion. This happens in a few hundreds of milliseconds. It involves the thalamus, amygdala and other areas in the limbic system and brain stem. These responses coalesce to form the first level of the hierarchy.

The emotion resulting from the instinct releases hormones into the bloodstream, preparing the body for fight or flight. Attention is also directed to the outer situation so that more information can be gathered to evaluate how dangerous it is for the individual either emotionally, psychologically, or physically.

Energy levels in the body, attention and the beginning of memory retrieval form the second level of the hierarchy of dynamic systems. Messages are sent to start the retrieval of memories in the neocortex. When was I in a similar situation? What happened? How did I get out of it? These implicit memories will help you later, if they become conscious, to plan how to react. Unfortunately, this process has only started, and the neocortex is very slow in relation to other areas of the brain which are taking control. The emotional content of implicit memories is experienced before the actual story is remembered giving you that 'Oh no, I did it again!' feeling before even realizing what 'it' was. The increased awareness may feed back into the first level, directing perception. You may realize that you were mistaken, that what you thought you saw was not at all what was happening, and the entire process may stop. However, if it doesn't, the split-off nature of the emotional situation gives it an archetypal quality. It is outside everyday experience.

The instinct which initiated this situation may bring with it a corresponding archetypal image, painting the situation in black and white terms. The ego may be watching this happen, and a realization (albeit tainted) of its importance and what this all means for your life locks the system, including the lower level dynamic systems, in place. The complex is constellated.

To summarize: State 1 in Figure 1, consisting of the initiating perception, instinct and related emotion may lead to State 2, the body reacting to the sudden emotion, a shift in awareness and the beginning of retrieval of episodic memory. State 2 may feed back into State 1. Together they may initiate State 3 with the realization of the importance of the event on one's life, locking in the constellation of the complex. This may be represented and acted out symbolically. The weak ego is overpowered by the complex, whereas the strong ego can differentiate what is happening now from the memories of what happened in the past. You are not in the same situation, and you are not obliged to relive it all again in the same way.

Archetype as instinct – image

Among Jung's many definitions of archetypes, he said that archetypes are 'forms' or 'categories' (Jung 1927/1931, para. 342), a system of classification

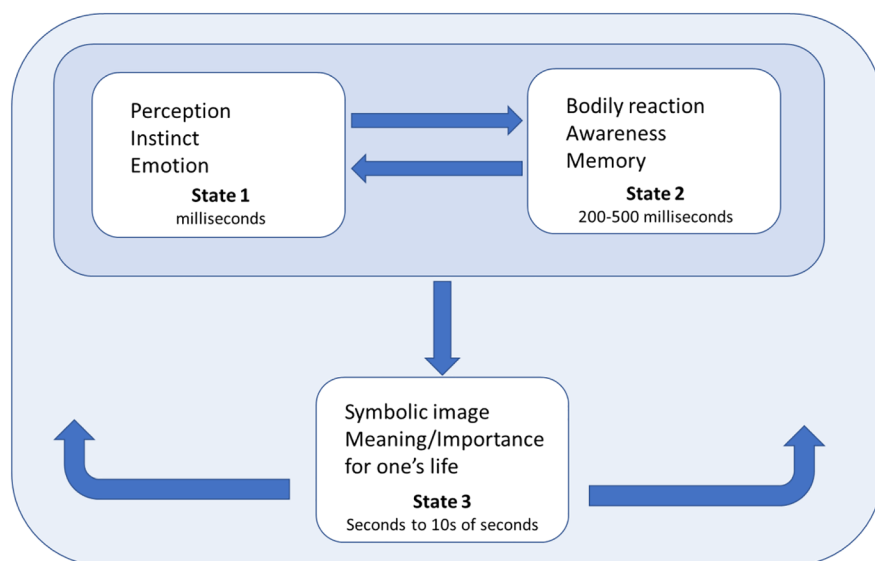


Figure 1. The constellation of a complex as a three-state hierarchal dynamic system
[Colour figure can be viewed at wileyonlinelibrary.com]

similar to the division of life forms into family, genus, species and so forth. They are simply themes (Jung 1947/1954, para. 401).

At the next level of complexity, this classification scheme has an order to it. The categories form patterns, revealing ‘a kind of pre-existent ground plan’ (Jung 1921/1971, para. 512). Like the blueprint of a house, it shows the basic supporting structures, which are ‘symbolic formulae’ (Jung 1921/1971, para. 625) similar to chemical formulae, but with symbols in the place of atoms. He called them ‘structural dominants’ (Jung 1942/1948, para. 222n). I understand this to mean that they are structures, or structuring elements, which predominate, they stand out. They are like the framework of a house - you first put up the big beams that will support the rest of the construction. They form ‘patterns of functioning’ (Jung 1938/1954, para. 152) and ‘patterns of behaviour’ (Jung 1957/1959, paras. 549-50; 1912/1955, para. 224; 1919, paras. 270, 274, 398; 1947/1954, para. 398), which are the two terms he used most to describe archetypes. We discern patterns in the way people function and behave. This implies that there is some reason, some ordering agency behind these actions, something that determines how people act.

He compared such patterns to the ‘axial system of a crystal ... the invariable geometric proportions underlying it’ (Jung 1938/1954, para. 155). We can see the crystal structure, but we do not so easily see why the crystal forms in a certain way. Nonetheless, there is an order which is very basic to the nature of the matter making up the crystal. He said that archetypes are ‘factors and

motifs that arrange the psychic elements into certain images' (Jung 1942/1948, para. 222n2) and 'factors responsible for the organization of unconscious psychic processes' (Jung 1952a, para. 841). These last two definitions stress that they are responsible, and have consequences, for how we understand and organize our perception.

Jung used the term 'image' to mean not only a visual picture, but to include a global sensorial and emotional experience of a situation. Archetypes are even more than these multi-sensation images; he called them 'dynamic images' (Jung 1917/1943 para. 184), implying intrinsic energy and even purpose. Archetypes are 'empirically derived postulates' which 'manifest themselves only through their ability to organize images and ideas, and this is always an unconscious process which cannot be detected until afterwards' (Jung 1947/1954, para. 440). A postulate is a hypothesis, a supposition, a statement that you propose to be true. This hypothesis is arrived at through observation ('empirically derived postulates').

Jung linked archetypes to instinct or evolution. He called them '*instinct's perception of itself*' (Jung 1919, para. 277, italics in original). They are 'representations of the meaning of the instinct' (Jung 1947/1954, para. 398), so not only the instinct, but the meaning of the instinct, and hence of the *need* behind the way certain instincts have led to survival of humans. They are our 'inborn mode of psychic apprehension' (Jung 1921/1971, paras. 624-5), in other words our *innate* way of perceiving. There is much debate in modern Jungian circles about whether the archetypes are innate, hard-wired into the psyche and the body at birth, or whether they are acquired. Moreover, if they are acquired, how much comes from culture? In his quite early writing, Jung defines them clearly as inborn, at least in part. He called them 'aptitudes' (Jung 1927/1931, para. 339), which are innate abilities, and 'an irrepresentable factor, a disposition' (Jung 1942/1948, para. 222). The archetype itself cannot be represented, only its effects (like the crystal structure mentioned above) or the archetypal image. Archetypes form 'a system of readiness for action' (Jung 1927/1931a, para. 53); an instinct could be described in the same way.

During the last century a number of attempts were made to establish a definitive list of instincts. None was successful. The term was dropped, replaced by the term 'behaviour' or 'innate behaviour', similar to Jung's term 'patterns of behaviour'. Jaak Panksepp has also largely replaced the term 'instinct' by 'primary process instinctual emotions', claiming they are innate, although some may not manifest immediately at birth (Panksepp & Biven 2012).

Ultimately, archetypes are 'living psychic forces' (Jung 1940/1951, para. 266), 'not mere objects of the mind, but are also autonomous factors, i.e., living subjects' (Jung 1952b para. 758) which have an 'invariable nucleus of meaning' (Jung 1938/1954, para. 155). These definitions view archetypes as independent, purposeful entities, similar to spirits or gods. Having so many definitions has led to much confusion about what Jung meant by archetypes,

but I don't think one definition needs to take precedence over another, it depends on what characteristics are under consideration.

We should never fail to make clear in our writing and thinking the distinction between the archetype itself and the archetypal image, for they are two very different phenomena. The archetype itself is very much related to nature and our place in it, to our bodies. Humans are born helpless, needing to be nurtured and loved. Less visible but also very important, is the need for structure, boundaries and rules. Hence the ubiquitous Mother and Father Archetypes associated with these two areas of need respectively. How these are represented in a culture determines the corresponding archetypal images, and how they play out in an individual life gives the corresponding Mother and Father Complexes. I would prefer other, more descriptive terms for these, since there is always the risk of conflation with the actual mother and father.

Thus, our basic human nature, with our corresponding needs, could be seen as 'a kind of pre-existent ground plan'² which can create 'forms' or 'categories'. To a large extent these determine the ways we 'function', our 'patterns of behaviour'. They are 'responsible for the organization of unconscious psychic processes'. Personally, I would not identify them as 'autonomous ... living subjects' which 'manifest themselves' but I accept that Jung and some Jungians do.

The archetypal *images* of the Great Mother, the Hero, the Divine Child etc. may be more or less related to a specific culture, but their underlying archetypes are common to all.

Complex as emotion + memory

Emotion. The principal characteristic of the constellation of an autonomous complex is its high emotional content. There have been many attempts to identify 'pure' emotions going back to classical Greece, if not earlier. Charles Darwin (1872) proposed joy, surprise, interest, fear, distress, anger, contempt, and shame. The Jungian author Louis Stewart (1987) has a list very similar to Darwin's (Anger, Sadness, Fear, Shame, Enjoyment, Love, Surprise, and Disgust³) which he links to instinctive, life-preserving responses. Jaak Panksepp considers there are seven 'basic affective systems': SEEKING (expectancy), FEAR (anxiety), RAGE (anger), LUST (sexual excitement), CARE (nurturance), PANIC/GRIEF (sadness), PLAY (social joy) (Panksepp & Biven 2012, p. xi). He uses capitals when labelling these systems to stress that they are functional networks as opposed to simple emotions *per se*.

² For all quotes in this paragraph, the references have been given earlier in this section.

³ In Charles Stewart's review of Louis Stewart's work (2008) he capitalizes the emotions.

We often experience a mixture of emotions at the same time, although one may predominate. Sadness is often mixed with anger, doubt, fear; desire with anxiety; play and joy with expectancy, and so forth. While working with a complex, it is important to separate out the various feelings and trace each back to its cause.

Memories. Memories anchor the complex in on-going life events, and may be either explicit or implicit. Implicit memories often involve patterns of relationship laid down in part in the ventral regions of the medial prefrontal cortex as part of the mirror neuron network very early in life during caregiver-infant interactions. These are learned patterns of interaction rather than explicit memories of actual experiences. The laying down of these memories is particularly active before four years of age (Keysers 2011, 184-6). These unconscious, implicit memories are retrieved faster than the slower conscious, explicit memories of previous events. The quality of our relationships has much to do with the meaning of our life experiences. Our long-term sense of self is to a large extent based on the type and quality of our relationships.

Archetypal image

Along with archetypal image Jung included 'patterns of functioning' and a 'preconscious psychic disposition' in his definition, making it a global experience, which places the current situation in context (Jung 1938/1954, para. 152). He said that the unconscious psyche functions more in such images than in words. He spoke first of the archetype as a 'primordial image'. Considering the archetype as instinct and image, the image is the opposite pole of the instinct and as such represents the goal of the instinct, the state the organism would be in if the instinctive action was successful.

Interpretation/meaning

As the complex constellates, we are confronted with an evaluation of the situation in terms of its relevance for us, particularly our goals or well-being. We extract meaning and make sense of the world by putting our experiences in context. This interpretation may or may not be conscious; it may or may not be formulated in words or images. The image or word may be symbolic. A symbolic image, or sometimes even one word, can adequately express a feeling or an entire situation more completely than many words strung together into useless sentences. We feel that sometimes the symbol, coming from the unconscious, encompasses and delimits what it is being expressed, giving a sort of handle on something that can otherwise not be grasped.

In Dynamic Systems Theory there can exist a specific order parameter which is key to locking the system in place and guaranteeing the emergence of a change in the state of the system. The emergence of the meaning or interpretation of the complex is such an order parameter, which synchronizes the other sub-systems and constellates the complex. The trigger for the constellation of the complex is in the present situation, but the images evoked use symbols and memories from the past to express the expected (and feared) situation in the future (Jung 1912/1954, paras. 365, 373).

Comparison with current neuroimaging studies

Introduction and presentation of the studies

There have been three major studies of Jung's theory of complexes using brain imaging techniques published in the *Journal of Analytical Psychology*: Petchkovsky et al. (2013 & 2017) and Escamilla et al. (2018). Slightly different techniques were used by the two groups, so this gives us a wider base on which to view the results. Both groups needed to modify the administering of the word association experiment due to noise from the equipment, so they used a computer screen to present the stimulus words, collect the response words, and measure the elapsed time. Both used the analysis proposed by Kast (1980) to evaluate the results and determine which words initiated a complex response. Petchkovsky et al. (2013 & 2017) used fMRI (functional Magnetic Resonance Imaging, accurate in indicating the location of areas active in the brain, but unable to measure time of activation under 2 to 3 seconds) and QEEG (Quantitative Electroencephalography) recording (accurate to millisecond timing but less accurate about location). Their combination of the two techniques gave interesting results. Escamilla et al. (2018) administered the word association experiment initially without using the imaging equipment in order to determine which words caused a complex reaction. They then repeated the experiment using first neutral words and then using a block of the five words causing the most complex-indicative results. This allowed them to record fMRI readings for a neutral state (no words), neutral words, and complex words. They could then subtract the neutral word results from those for the complex words in an attempt to identify the results due specifically to the complex. They identified two circuits in the brain which were activated in response to the stimulus words; the activation of regions in the first circuit (1) was statistically significant ($p < 0.05$), and the second circuit (2) was preferentially activated ($p = 0.07$)⁴.

⁴ The p-value indicates the significance of the result. It has values between 0 and 1. Results with $p < 0.05$ are statistically significant, meaning that it is likely valid for the larger population.

QEEG timing study vs dynamic systems theory

The findings published by Petchkovsky (2017, p. 415-433) with regard to the activation times in various regions of the brain during the response to a complex are in the same order of magnitude as those predicted by the dynamic systems approach presented above and published earlier (Krieger 2014, p. 64-5)

Petchkovsky et al. (2017, p. 425) mention that both their QEEG and fMRI studies indicate interaction between the left and right hemispheres. It has been proposed that such global activity is instrumental in the emergence of consciousness (Baars 1988, 2005; Dehaene et al. 2001; Krieger 2014).

Initial reaction

The word association experiment is designed to *activate*, not to *constellate*, all of the complexes in a person’s psyche. By activation as opposed to constellation, I mean a much milder reaction. In an actual constellation, perception triggers the complex. We see or experience a situation, often involving danger, either physical or psychological, which stimulates an instinctive, emotional reaction and initiates the retrieval of episodic memories of similar, past experiences. During the word association experiment, the

Table 1. Comparison of measured and predicted activation times and processes

QEEG	Dynamic Systems Theory
Within the first 16 ms: activity in the right middle temporal region and amygdala (limbic system stress/fear response)	Milliseconds: the instinct (archetype) initiates an emotion (limbic system). Activation of areas in the neocortex related to memory retrieval begins.
150 ms: activation of the anterior cingulate and precuneus. Both probably involved in a background sense of self. Their studies showed this is only active during this very early period. Indicating a possible shift from a background awareness to an active focusing of attention.	200-500 ms: Shift in the level of awareness and activation of a sense of self. Instrumental in a sense of self are the cortical midline structures on the inside of the neocortex adjacent to the limbic system. At 400 to 500 ms: Episodic memories may begin to become conscious.
From about 1000 ms (1 second) onwards to next 3 seconds: left hemispheric activity (probably defensive in nature) – beginnings of a conscious fear response.	Seconds to tens of seconds: Conscious realization of the situation, first in the form of an image and later in words.

ms: millisecond (1000 milliseconds = 1 second). It takes the brain 500 to 1000 milliseconds to become aware (conscious) of something perceived.

subject is in a protected environment and aware they are participating in an experiment. To a certain extent, this mitigates the startle which often accompanies the constellation of an autonomous complex, but the complex is activated none the less, as is shown in these imaging studies. During the word association experiment, it is the stimulus word which begins the activation of visual and episodic memories in the lateral cortex, the areas identified by Escamilla et al. in both circuits 1 and 2. They also noted activation of areas in the temporal lobes related to language in circuit 2, which one would expect since both the stimulus and response involve language. The design in this study of grouping five complex words together would probably have the effect of reinforcing the appearance of complex indicators. Jung describes the use of a similar technique in order to unmask a suspected thief (Jung 1905).

In the QEEG study, Petchkovsky et al. identified activity in the right amygdala indicating a fear response within the first 16 ms. Both circuits 1 and 2 in the Escamilla et al. study indicate the feeling tone which is activated; in circuit 1 they are associated with feelings of uncertainty, and in circuit 2 with the integration of sensory information: emotions of fear, anger, and eventually sexual pleasure. They mention the involvement of the caudate, which is next to the thalamus and is involved in the integration of past memory with learning and goal-directed behaviour. Nothing can be inferred from the fMRI studies about the speed of these reactions. I would propose that they are initiated very quickly in this initial stage, much before there is any conscious awareness.

Energy level, awareness and memory

The second psychic state in the constellation involves the bodily reaction and a shift in the level of awareness and activation of a sense of self⁵. It would be interesting if measurements from other areas of the body, such as blood pressure and heart rate, could be combined with the neuroimaging measurements. This would give an indication of the change in energy level and the preparation of the body for eventual reaction to a possible danger. Petchkovsky et al. (2013) mentions that this was not technically feasible.

Petchkovsky et al. (2017) noted the activation of the anterior cingulate and precuneus in the right hemisphere starting at 150 ms. These areas form part of what is called the default mode network (discussed in more detail below), forming a background sense of self. Decreased activity in this area may indicate the beginnings of an awareness of oneself in potential danger, which will then develop from a background sensation into a more acute awareness. The second circuit identified by Escamilla et al. is more complex. They point

⁵ All references to self are to a personal experience of one's self, not the Jungian concept of the archetypal Self.

out the connection between the neocortex with areas in the limbic system (the caudate, thalamus and cingulate), thus linking emotion and memory. Areas in the temporal and parietal areas in both the left and right hemisphere are activated. This involves connections through the temporal cortex with the hippocampus (visual and episodic memory) and amygdala (emotions, mainly fear and anger), the parietal lobe (directing attention) and additional areas in the temporal lobe dealing with assignation of meaning and comprehension of language. It seems reasonable, since we are using the *Word Association Experiment*, that areas relating to language are activated, perhaps more so than in the actual situation which triggers a complex. However, I also question whether, as discussed earlier, the response word may, in some cases, be considered as a symbol, expressing in that case more than an association, but representing the complex in its entirety of memory and emotion.

Where am 'I' in all of this?

'I' is a very complicated concept, even limiting it to the perspective of brain anatomy and ignoring psychological and philosophical implications. Neither Petchkovsky nor Escamilla refer explicitly to a sense of self being called into action, the triggering of 'I am in danger and I must act'. Northoff et al. (2006), in an extensive review of many imaging studies of the self, show that our self-awareness is scattered in many areas of the brain, with autobiographic and emotional memories in the lateral cortex. These would be the areas mentioned as part of circuit 1 by Escamilla et al. The more elementary, pre-reflective aspects of the self across all functional domains are located in the central, medial areas. Northoff et al. identified these as the cortical midline structures (CMS). These have been grouped into area and functional clusters corresponding to specialization within the cortical midline structures: emotional, facial, memory, motor, social (self with other and self as opposed to other), spatial and verbal.

Do the cortical midline structures correspond with the ego? I would argue not. Studies have shown that it is most active when we are involved in self-referential activities such as thinking about ourselves or daydreaming. It has been associated with a 'physiological baseline' and forms part of what has been called the 'default mode network' (DMN) (Northoff et al. 2006, p. 450). Any activity, even relatively passive pastimes such as reading, diverts activity from the cortical midline structures (ibid., p. 452). This has been confirmed in several other studies, including that of Petchkovsky et al. (2017, p. 424). Thus, although the cortical midline structures and the default mode network could be considered part of it, the ego is a representation of the self also during normal activities, not only during resting, self-referential reflection.

In addition to the default mode network, two other major networks have been identified in the brain that relate to the concept of 'I'. One is the Central

Executive Network (CEN) which, as the name implies, has to do with problem-solving and decision-making. It is located in the top frontal regions, including the dorsolateral prefrontal cortex, which is referred to in the Petchkovsky studies. Operating and switching between being at rest (default mode network) and intellectually active (Central Executive Network) is the Salience Network (SN), which includes large areas in the anterior insula and anterior cingulate (referred to in both the Petchkovsky and Escamilla studies). The SN is actively concerned with identifying and evaluating the effect on the self of external events. It is very active during the integration of emotional and cognitive information of the self in social situations and communication. It can filter out or amplify incoming information of either a learned or instinctive nature, and further evaluating emotional input and directing attention to salient information. The SN plays an important role in switching between the default mode network and the Central Executive Network (Menon, 2015). It is interesting to speculate to what extent archetypal patterns could be discerned in the functioning of these networks.⁶

An 'autobiographical self', such as Damasio (1999, 2010) describes, is very much centred around our autobiographical, episodic memories, such as those activated during the word association experiment (Escamilla et al. circuit 1). In contrast, an affect/emotional centre, such as the 'core-self', described by Damasio (ibid.) and the 'core SELF' by Panksepp and Biven (2012) situated in the cortical midline structures does not seem to be overly active in either circuit defined by Escamilla et al. The cingulate cortex mentioned in circuit 2 is the only area which overlaps with the regions Northoff et al. mention as part of the cortical midline structures. It is quite a large area of the limbic system receiving input from both the thalamus (also mentioned in circuit 2) as well as from the neocortex. The fact that they are not specifically mentioned in the Escamilla study does not mean they were not active, only that there was not increased activity triggered by a complex word. Circuits 1 and 2 are areas with increased activity compared to the neutral words. Activation of a core self is implied when 'feelings of uncertainty', a 'feeling tone' associated with the cingulate, and 'attention in response to memories' in circuit 2 are mentioned by the Escamilla team (Escamilla et al. 2018, p. 496). Both feeling and attention imply a self which is doing the feeling and is paying attention.

Final stage in the activation/constellation of the complex

I argued above that the constellation of the complex is locked into place by the conscious realization that one may be affected by the situation, usually negatively. In the QEEG study, Petchkovsky et al. noted first the reduction of activity in the default mode network, then activation of the insula and the

⁶ Petchkovsky et al. (2017, p. 417) mentions the DMN, SN and DEF.

anterior cingulate cortex (SN), and last they specifically noted activation of the dorsolateral prefrontal cortex, particularly in the right hemisphere (Central Executive Network). Taken together, these could show a deactivation of the default mode network, activation of the SN and finally a realization of the Central Executive Network, particularly with regard to the control of emotion. I propose that the network put in place when the complex constellates consists of restricted emotions and memories inhibiting access to the full range of normal functioning. Retelling and reexperiencing this 'splinter' Central Executive Network in analysis links these memories to the full palette of the normal ego.

Considering how the constellation of the complex affects the concept of the self, particularly in a social context, it is interesting that both the Petchkovsky and Escamilla studies found activation of mirror neuron areas. We tend to think of mirror neurons exclusively in terms of socially desirable phenomena such as empathy and compassion, but they are also involved in internalizing the angry faces expressing negative emotions and thereby potentially involved in the formation of the complex, particularly in relation to early developmental patterns of relationship. Consequently, there is activation of areas related to self, other and conflict control. The insular cortex (related to images of self and other) has direct links with the limbic system (emotion) and bodily reactions. The QEEG studies of Petchkovsky et al. confirmed that after about one second the left hemisphere dominates, which they interpret as a probable defensive reaction. This hemisphere is also usually associated with language.

A final word on the word association experiment - imaging studies

The following table summarizes the results of both studies related to the proposed sequence of events taking place during the constellation of a complex. It needs to be mentioned again that the fMRI studies give no information about the timing of events. I have aligned the activity in regions of the brain with phenomenological reactions experienced during the constellation of a complex. I kept mainly to the exact terms used in the reports of the studies. Comments in italics are my interpretation.

I believe this chronological presentation illustrates the initial emotional reaction (limbic system activation), the interruption of the default mode network by the activation of implicit episodic memories, the interaction of the SN to a possible threat, and the activation of the Central Executive Network in the determination of an appropriate reaction and/or selection of the response word. The Central Executive Network may be a large cluster comprising the ego-complex if no complex is constellated, or a 'splinter' cluster, an autonomous complex.

Table 2. Summary of empirical findings arranged in order of the three states proposed by the Dynamic Systems hierarchy

Petchkovsky et al. QEEG	Pechkovsky et al. fMRI	Escamilla et al. Circuit 1	Escamilla et al. Circuit 2	Krieger
(Dynamical systems hierarchy)				
	Mirror neurons: self-other interactions	Superior parietal cortex: Implicit somatic and episodic memory including self-other interactions	Temporal cortex and connections with hippocampus and amygdala: Implicit visual and episodic memory	Perception Activation of episodic memories
Right amygdala (<i>limbic system</i> fear response)	Fear-driven inhibitory response	Feeling tone: uncertainty. Parietal lobe: integration of somatic and sensory information (SN) Body reaction: frontal lobe, post central gyrus, primary motor cortex (mirror neurons, control of movement)	Thalamus and Cingulate gyrus: emotional response (SN)	Emotional response
				Change in energy level
Activation and then reduction of activity of the	Anterior insula (self-awareness and emotional empathy).		Bilateral activation of temporal and parietal cortex: <i>The bilateral</i>	Awareness

(Continues)

Table 2. (Continued)

Petchkovsky et al. QEEG	Pechkovsky et al. fMRI	Escamilla et al. Circuit 1	Escamilla et al. Circuit 2	Krieger
(Dynamical systems hierarchy) anterior cingulate and precuneus (DMN)	Cingulate gyrus (self- awareness and conflict monitoring). <i>Both major elements in the SN</i>		<i>activation is important for the emergence of consciousness. Changes in attention.</i> Caudate – <i>integration of past memories in determining goal directed behaviour</i>	Retrieval of episodic memories
	Activation in the right dorsolateral prefrontal cortex. Left hemispheric activity (language) (CEN)	Frontal lobe and parietal cortex (including mirror neurons); planning and control of behaviour (CEN)	Middle and superior temporal gyrus: Language and meaning (CEN)	Symbolic image and Meaning for one's life

One of the points these studies have underlined is the change in awareness brought on by the constellation, and even the activation, of a complex. We can conceptualize the change in awareness from the ego complex to the autonomous complex, as Jung predicted. Working on the complexes in analysis, realizing what is self and what is the internalized 'other', allows us to take back the repressed emotions being projected onto the current situation and the real 'other'. We can now differentiate what is self from what is other, allowing for compassion for both Table 2.

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TRANSLATIONS OF ABSTRACT

L'examen des écrits de Jung sur le 'complexe affectivement chargé' montre qu'il considérait ces complexes comme des éléments psychiques indépendants, clivés. Des innovations modernes de la pensée scientifique et de la technologie, la Théorie des Systèmes Dynamiques et la neuro-imagerie, nous permettent de mieux définir et d'étudier ce phénomène psychique. Penser la constellation du complexe en tant que hiérarchie de systèmes dynamiques permet de faire des prévisions sur le « timing » de l'activité du cerveau. Ceci a été confirmé par deux études indépendantes utilisant l'IRMf et l'EEGQ durant la passation du Test d'Association de Mots, l'outil que Jung a utilisé il y a plus d'un siècle pour explorer le fonctionnement psychique/du cerveau. Utilisant comme cadre de travail la constellation du complexe considérée comme une hiérarchie de systèmes dynamiques, j'examine les études sur la neuro-imagerie rapportées par Petchkovsky *et al.* (2013, 2017) et Escamilla *et al.* (2018). Ces études apportent la conclusion que les prédictions théoriques quantitatives et les résultats expérimentaux sont en accord et dans le même ordre de grandeur. Le changement dans l'attention produit par la constellation d'un complexe peut également être compris comme un basculement: l'abandon du système neuronal standard et la réaction de sursaut qui active le fonctionnement exécutif dans le cortex frontal soit du complexe du moi soit d'un complexe autonome.

Mots clés: complexe, archétype, la psyché en éclats, Association de Mots, Expérience d'Associations de Mots, système dynamique, IRMf, EEGQ

Eine Rückschau auf Jungs Schrift über den 'gefühlbetonten Komplex' zeigt, daß er ihn als unabhängiges, abgespaltenes psychisches Element ansah. Die modernen Fortschritte in wissenschaftlichem Denken und in Technologie, namentlich in der Theorie dynamischer Systeme und in der Neurobildgebung, ermöglichen es uns, dieses psychische Phänomen besser zu definieren und zu untersuchen. Die Betrachtung der Konstellierung des Komplexes als Hierarchie dynamischer Systeme ermöglicht eine Vorhersage des Zeitpunktes der Gehirnaktivität. Dies wurde durch zwei unabhängige Studien unter Verwendung von fMRT und QEEG bei der Durchführung des Wortassoziationsexperimentes bestätigt, dem Tool, mit dem Jung vor über einem Jahrhundert die Funktion des Gehirns und der Psyche untersuchte. Unter Nutzung der Stadien der Konstellierung eines Komplexes, welche als Hierarchie dynamischer Systeme gesehen werden, als Rahmen, betrachte ich die von Petchkovsky *et al.* (2013, 2017) und Escamilla *et al.* (2018) vorgelegten Studien zur Neurobildgebung die zu dem Schluß kommen, daß quantitative theoretische Vorhersagen und experimentelle Ergebnisse in signifikantem Maße übereinstimmen. Die Veränderung der Aufmerksamkeitsspannung, die durch die Konstellierung des Komplexes verursacht wird, kann auch verstanden werden als Umschalten eines Standardneuronetzwerkes, als eine schreckhafte Reaktion, die impulsgebende Funktionen im Frontalkortex aktiviert, entweder solche des Ego-Komplexes oder eines autonomen Komplexes.

Schlüsselwörter: Komplex, Archetyp, gespaltene Psyche, Wortassoziation, WAE, dynamisches System, fMRT, QEEG

Un'analisi degli scritti di Jung sui 'complessi a tonalità affettiva' mostra che egli li considerava elementi psichici indipendenti e autonomi. I progressi moderni nell'esplorazione scientifica e nella tecnologia, in particolare la Teoria dei Sistemi Dinamici e la risonanza magnetica funzionale, ci permettono di definire ed esplorare meglio questo fenomeno psichico. Considerare la costellazione del complesso come una gerarchia di sistemi dinamici consente di prevedere i tempi dell'attivazione cerebrale. Questo è stato confermato da due studi indipendenti che hanno utilizzato RMIf e EEGQ durante l'esperimento di Associazione Verbale, lo strumento utilizzato da Jung per investigare il funzionamento cerebrale/psichico oltre un secolo fa. Utilizzando gli stadi della gerarchia della costellazione di un complesso di sistemi dinamici al lavoro, analizzo gli studi di diagnostica per immagini riportati da Petchkovskt et al. (2013, 2017) e Escamilla et al. (2018), concludendo che le previsioni teoriche quantitative ed i risultati sperimentali concordano significativamente. Il cambiamento di attenzione causato dalla costellazione del complesso può anche essere concepito come una variazione da un default di un network neuronale, una reazione allarmante che attiva il funzionamento esecutivo nella corteccia frontale o del complesso dell'Io o di un complesso autonomo.

Parole chiave: complesso, archetipo, psiche scindibile, Associazione Verbale, Esperimento di Associazione Verbale, sistema dinamico, RMIf, EEGQ

Обзор работ Юнга по «чувственно окрашенным комплексам» показывает, что он понимал комплексы как независимые, отщепленные психические элементы. Современное научное мышление и технология, а именно теория динамических систем и нейро-образов, позволяет нам лучше определить данный психический феномен, а также исследовать его. Рассмотрение констелляции комплекса как иерархии динамических систем позволяет предсказать временные рамки мозговой активности. Это нашло подтверждение в двух независимых исследованиях с использованием фМРТ и количественной ЭЭГ во время проведения словесного ассоциативного эксперимента, методики, которую Юнг использовал более века назад для изучения мозгового/психического функционирования. Рассматривая стадии констелляции комплекса как иерархию динамических систем, я провожу обзор нейро-образов, изученных в исследованиях Petchkovsky *et al.* (2013, 2017) and Escamilla *et al.* (2018). В качестве вывода предполагается, что количественные теоретические предсказания и экспериментально полученные результаты - это величины одного порядка. Изменение внимания, вызванное констелляцией комплекса, так же может быть понято как переключение с дефолт системы мозга (сети пассивного режима работы мозга), как старт-рефлекс, активирующий исполнительную функцию во фронтальной коре либо при констелляции эго-комплекса, либо автономного комплекса.

Ключевые слова: комплекс, архетип, расщепленная психика, словесный ассоциативный тест, динамическая система, фМРТ, кЭЭГ

Una revisión de los escritos de Jung sobre los 'complejos de tonalidad afectiva' muestra que el consideraba a los mismos como elementos psíquicos independientes y disociados.

Los avances modernos en el pensamiento científico y en la tecnología, específicamente la Teoría de los Sistemas Dinámicos y la neuro-imagen, nos permite explorar y definir este fenómeno psíquico de mejor manera. Considerar la constelación de un complejo como una jerarquía de sistemas dinámicos posibilita la predicción del ritmo de la actividad cerebral. Esto ha sido confirmado por dos estudios independientes utilizando fMRI y QEEG durante la administración del Experimento de Asociación de Palabras, la herramienta utilizada por Jung para investigar el funcionamiento cerebral/psíquico un siglo atrás. Utilizando como marco de referencia, las etapas de la constelación de un complejo visto como una jerarquía de sistemas dinámicos, presento una revisión de estudios de neuro-imágenes reportados por Petchkovsky *et al.* (2013,2017) y Escamilla *et al.* (2018), concluyendo que las predicciones teórico cuantitativas y experimentales están en concordancia dentro de un orden de magnitud. El cambio de atención causado por la constelación de un complejo puede también ser concebido como un cambio desde el default neuro-network, una respuesta de sobresalto que activa el funcionamiento ejecutivo en la corteza frontal tanto del complejo del ego, como de un complejo autónomo.

Palabras clave: complejo, arquetipo, psique fragmentada, Asociación de Palabras, WAE, sistema dinámico, fMRI, QEEG

对荣格关于“情感基调的情结”的综述显示，他把它们视为独立的、分离的心理成分。现代先进的科学思想和技术，即动力系统理论及神经成像技术，可以允许我们更好地探索和定义这个心理现象。假如把情结的聚集视为一个动力系统的层级结构，我们就可以基于此预测脑活动的时机。已有两个独立的研究证实了这一点，这两个研究分别在词语联想（即荣格在一个世纪以前用于研究脑/心理功能的工具）进行的同时使用了fMRI和QEEG。我把情结看作是动力系统的层级结构，以其不同阶段作为架构，来综述Petchkovsky等(2013, 2017)和Escamilla等(2018)所报告的神经成像研究，并得出结论，定量的理论预测和实证结果在量级上可以取得一致的结果。情结聚集所带来的注意的改变还可以是默认的网络的开关，即一个由惊吓反应触动的，处于额叶的执行功能，这一功能可能是关于自我情结的或是自主情结的。

关键词：情结，原型，碎片化的心灵，词语联想，WAE，动力系统，fMRI，QEEG
