CHAPTER - I

INTRODUCTION
When asking questions about the validity of arousability as a distinct temperamental trait, one is confronted with the basic difficulty of defining temperament first.

Temperament like intelligence and/or physique might be said to designate a class of raw material from which personality is fashioned. It refers to the chemical climate or internal weather in which personality evolves. The more anchored a disposition is in native constitutional soil, the more likely it is to be spoken of as temperament.

Gordon W. Allport was of the view that “Temperament may be regarded as the characteristic phenomena of an individual’s emotional nature, including his susceptibility to emotional stimulation, his customary strength and speed of response, the quality of his prevailing mood and all peculiarities of fluctuation and intensity in mood, these phenomena being regarded as dependent upon constitutional make up and therefore, largely hereditary in origins.”

Bates (1987) provided a definition of temperament which conveyed its distinctive characteristics: biologically rooted
individual differences in behaviour tendencies that are present early in life and are relatively stable across various kinds of situations and over the course of time.

Strelau (1983) assumed that temperament consisted of a set of 'formal', relatively stable traits which are revealed in behaviour at the level of energy and in the temporal patterning of reactions. The term formal was used to emphasize the notion that temperament per se has no content and does not determine the content of behaviours in any direct way. But the possibility of indirect influence can not be ruled out.

As one of the regulatory mechanisms of behaviour, temperament is manifested in all kind of reactions (actions) independent of their direction or content. Temperament, conditioned by structural and functional properties of an individual, has an effect on the course of actions by determining, alone or in conjunction with other factors, the energy level and the temporal characteristics of action.
Being primarily determined by inborn physiological mechanisms, temperament is subject to changes caused by maturation and by some environmental factors.

Teplov (1956) recognized the influence of auto and post-natal factors and the results of early social experience on shaping up of temperament. According to Teplov (1956), the interaction of temperament and early environment described as character— with aptitudes, constitutes personality. In his later works, Pavlov also acknowledged the importance of environmental factors, arguing that while each individual belongs to one or another temperament class, his or her actual behaviour (the phenotype) depends on experience.

GENESIS OF THE NOTION OF TEMPERAMENT

Hippocrates (5th Century B.C.) believed that the condition of the organism mainly depended on the quantitative proportion (crisis) of 'juices' or fluids in the body (blood, lymph, bile). Several centuries later, Roman physicians changed Greek “crisis” to Latin “temperamental” (a mixing in due proportion) and the
term survived till our times. Gradually ancient science came to view mental characteristics of individuals as a function of crisis or temperament, i.e. of the proportion of vital juices in the body. Roman anatomist Galen living in the 2\textsuperscript{nd} century B.C. was the first to give a detailed classification of temperaments which included 13 types. Subsequently, their number in ancient medicine was reduced to 4 distinguished by the prevalence of one of the four bodily fluids: blood, lymph, yellow bile, black bile and called respectively, \textit{sanguine} (L. Sanguineous – blood), \textit{phlegmatic} (Gr. Phlegma – Slime), \textit{Choleric} (Gr. Cholera – Yellow bile) and \textit{melancholic} (Gr. Melancholia – black bile).

Numerous hypotheses put forward in later centuries attempted to account for differences between temperaments. The importance of ancient physicians on scientific thought is attested to by the significance attached to the \textit{humoral} (moisture, fluid) systems of the organism. For instance, German philosopher Immanuel Kant (the late 18\textsuperscript{th} century) believed that temperament was determined by blood properties. Very close to this view was the theory of Russian anatomist and physician Pyotr Lesgaft who
wrote (in the late 19th and early 20th centuries) that temperament is a function of blood circulation, particularly the thickness and elasticity of the walls of blood vessels, their inner diameter, the form of the heart, etc. According to this theory, the blood flow rate and pressure determine the individual excitability characteristics of the organism and the duration of its reaction to different stimuli.

German psychiatrist Kretschmer (starting from the 1920s) contended that the mental make-up of the individual corresponds to his build, the general bodily constitution. According to him, the connection between the type of the constitution and some mental qualities is traceable to their common base i.e. the chemical composition of blood and the hormones secreted by the glands of the endocrine system. Kretschmer’s system focused on three basic types: pyknic (stocky), asthenic (slender) and athletic (muscular); and one mixed type: dysphasic. He sought to relate body type to propensity for mental disorders. He argued that the asthenic was prone to schizophrenia, the pyknic to manic depression and the athletic to sanity.
US scientist Walter Sheldon (The 1940s) also believed that individual physiological traits are directly related to bodily builds controlled by the hormonal system i.e. to the relationship between different organism’s tissues. He argued that there are three primary components of physique and three primary components in temperament attached to them. These are: Ectomorphic (thin, light bones and muscles) – cerebrotonia (restrained, self conscious, fearful), Endomorphic (heavy, poorly developed bones and muscles) – visceretonia (losing, sociable, comfortable) and Mesomorphic (strong, well developed bones and muscles) – somatotonia (adventurous, vigorous, physical activities).

Considering the significant role accorded to organism’s fluids or juices in temperament, it is not surprising that these ideas also form the basis of treatise of ancient Indian seers – Charaka and Sushruta (600-300 B.C.) They developed the Ayurvedic concept of ‘prakriti’ (temperament) which is based on three ‘dosas’ : Vata, Pitta & Kapha – based on examination and interrogation method.
Persons having predominance of Vata have lean and stiff body, rough and dry skin, prominent blood vessels and low body temperature. These individuals require little sleep and are hyperactive. Being quick in their mental processes and initiation of action, they show early initiative in work but because of the dry quality of vata, lose strength and become tired easily.

Pitta Prakriti individuals have soft and flabby muscles and joints, high metabolic rate which leads to excessive perspiration and excretion and a tendency to eat and drink a lot and often. Pittaja persons are brave and courageous but cannot tolerate exertion. They are irritable, get easily provoked and upset, through they also calm down quickly. Due to sharp and quick action, they have a very good, intellect, grasping power and memory.

Kapha predominating persons are short, heavy and strongly built with clear attractive and bright faces. Their pulse is slow and full in volume. Kaphaja individuals are slow in their activities and have slow excitability but they have strong perseverance and are emotionally mild, peaceful and steady.
They have excessive and deep sleep and are slow in talk and walk. No associated movements are seen while working.

The aforesaid description goes with individuals having preponderance of one dosha over the other two. Mostly the prakriti is the combination of two doshas, what Charaka called ‘Dwandvaja Prakriti’. A perfect balanced constitution of the three doshas neutralizes bad or unwanted aspects and is called as “Sannipatika”.

**FORERUNNERS OF THE CONCEPT OF AROUSAL**

The above-described traditional psychology of temperament with its static description of the innate properties of behaviour, has been presented purely from a historical point of view. This approach came almost to a complete halt when psychologists began to focus their attention on activity and upon dynamic aspects of the regulatory functions of behaviour.

The original idea that temperament may be characterized by means of life energy which oscillates from excitability to drowsiness was proposed by Immanuel Kant (1912). This idea
was further developed by the German psychiatrist Gottfried Ewald. According to Ewald (1924), the life energy is limited by a so-called biotonus in which individuals differ. Biotonus refers to the quantitative aspects of behaviour, expressed in intensity and tempo characteristics, which are regarded as the core of human temperament. Metabolic processes, the functioning of the endocrine system, and the sensitivity of the nerve cells were considered by Ewald as determinants of the biotonus. Ewald viewed mechanisms underlying the energetic characteristics of behaviour (biotonus) as highly complex and in interaction with each other - a statement that corresponds with contemporary views on the determinants of the energetic characteristic of behaviour.

Some of the first experiments that involved constructs referring to the central nervous system (C.N.S.; Hebb, 1955) were undertaken by Pavlov (1951/1952) during the first 3 decades of this century. Pavlov put forth the concept of the excitatory processes which relates to the "excitatory substance" of the cortex and sub cortex. The excitatory substance can be
viewed as a C.N.S. construct underlying the concept of arousal. According to Pavlov, the intensity of excitatory processes is, to a given extent, a function of the intensity of stimuli (the law of strength). After a critical point, excitation passes into protective (transmarginal) inhibition that is expressed in a decrease or disappearance of reactions (performance). The Pavlovian concept of protective inhibition is also used by contemporary researchers as a C.N.S. construct, which can be used to explain findings referring to such arousal - oriented traits as extraversion (Eysenck, 1970, 1991), augmenting – reducing (Buchsbaum, 1976), and sensation seeking (Zuckerman, 1979, 1991).

On the basis of this research (manipulating hunger and different doses of caffeine and bromine to pharmacologically change the level of excitatory processes), Pavlov (1951/52) introduced the concept of strength of excitation, understood as a trait (similar to the construct of arousability), from which he was able to explain individual differences in the intensity of excitatory processes.
Pavlov used the term strength of excitation interchangeably with the term strength of nervous system (NS). It is manifested in its withstanding strong and or prolonged excitation without slipping into transmarginal inhibition. Excitatory strength, measured by resistance to extinction with reinforcement is a consequence of low reactivity, and weakness a consequence of high reactivity or sensitivity of receptors and cortical projection areas (Nebylitsyn, 1957, 1960; Teplov, 1956).

Strength of the nervous system with regard to inhibition is endurance of continuous or frequently repeated inhibitory stimuli. It is measured by increasing the duration or frequency of presentation of an inhibitory conditioned stimulus and observing any consequent disruption of the inhibitory conditioned reflex (Nebylitsyn, 1963).

**THE CONCEPT OF GENERAL AROUSAL**

Arousal is of special interest to personality psychologists because this concept appears to provide the basis for integrating individual differences in physiology, subjective experience and
behaviour. According to Elizabeth Duffy (1957), all kinds of behaviour may be described as variations in either the direction of behaviour or the intensity of behaviour: “It is the intensity aspect of behaviour which has been variously referred to as the degree of excitation, arousal, activation or energy mobilization”.

Duffy hypothesized that the degree of energy mobilization (arousal, activity) is regulated through metabolic activity and may vary from deep sleep to extreme excitement (Duffy, 1951).

Duffy (1951, 1957) considered arousal as a general, undifferentiated phenomenon underlying temperament, which she identified with the intensity dimension of behaviour. Arousal, which consists of the release of potential energy for use in activity or response, is determined by physiological factors such as endocrine secretion, food, drugs, and the degree of effort required by the situation (e.g. difficult task, stress). Energy release is reflected in a number of physiological processes, such as tension of the skeletal muscles, electro dermal activity (EDA), and electroencephalographic activity (EEG). Duffy’s (1957) statement that individuals differ in the level of arousal and
responsiveness to stimulation was of special significance for studies on temperament. This idea was most extensively elaborated by Gray (1964) when he introduced the concept of arousability.

The concept of arousability was most influential in the development of personality dimensions with respect to arousal theories. It also allowed the convergences between the concept of nervous system strength and the theory of activation/arousal to be pointed out. Individuals who are low on the dimension of arousability (i.e. who, in any given stimulus situation, show relatively low levels of arousal) correspond to individuals with a strong nervous system; individuals who are high on the dimension of arousability (i.e., who, in any given stimulus situation, show relatively high level of arousal) correspond to individuals with a weak nervous system (Gray, 1964).

Hebb (1955) after reviewing the many data or behaviour under deprivation, arrived at three conclusions important for further studies relating concepts of arousal and/or activation to temperament characteristics. First, by analysing sensory events,
Hebb distinguished two main functions that stimulation plays in the organism. One function refers to the direction of behaviour – which Hebb termed as cue function; the other function refers to the energetic background of any kind of behaviour – which Hebb called the arousal or vigilance function. Without a foundation of arousal, the cue function cannot exist. (Hebb, 1955).

Second, Hebb considered arousal as synonymous with general drive state. “The drive is an energizer, but not a guide; and engine but not a steering gear”. According to Hebb, this characteristic of a drive fully refers to the activity of the arousal system that he located, after Moruzzi and Magoun (1949), in the brain stem. Hebb intended to emphasize that a given level of arousal is indispensable for any behaviour, regardless of whether in humans or animals.

Third, Hebb believed that there exists an optimal level of arousal. The fact that a nonlinear (inverted U-shaped curve) relation occurs between the intensity of stimuli (to which the concept of arousal refers) and the speed of learning was already known at the beginning of this century (Yerkes and Dodson,
The level of arousal under which performance of any kind is most efficient is regarded as the optimal level of arousal (Schlosberg, 1954). Hebb developed this idea by showing that the level of arousal can be regarded as optimal not only from the point of view of efficiency of performance but also in respect to its rewarding functions. At low levels of arousal, an increase in drive intensity (high stimulation) may be rewarding; whereas at high levels of arousal, a decrease in drive intensity (low stimulation) has a rewarding value.

Although Hebb played a leading role in emphasizing the role of behavioural energy level and its relation to individual differences, later on, many such theories appeared under different guises, e.g. Petrie's (1967) theory of individual differences in stimulus intensity modulation, Zuckerman's (1979) sensation-seeking theory, and Sales' (1971) concept of the need for stimulation as a trait specific to each individual.
AROUSAL AS NEUROPHYSIOLOGICAL CONSTRUCT

The revolutionary discovery by Moruzzi and Magoun (1949) that the cat’s brain stem reticular formation (BSRF) produces unspecific activations, and that the stimulation of the BSRF desynchronizes and increases EEG activity, had an essential influence on the concept of arousal. Since this discovery, arousal – besides its traditional role as a general construct – has also been treated as a neuropsychological construct. Lindsley (1952), Samuels (1959), and Berlyne (1960) showed that the activity of the ascending reticular activating system is responsible for the organism’s levels of wakefulness (alertness), which is characterized by such states as coma and deep sleep on the one extreme and strong, excited emotions (fear, rage, anxiety) on the other extreme (Lindsley, 1952).

The maintenance of optimal level of arousal is important not only from the point of view of efficiency but also because hypo or hyper arousal can cause a variety of disorders.

One of these disorders is attention deficit disorder with hyperactivity (ADDH). Mostly found in school-aged children the
disruptive behaviors include: “non-goal-directed” motor activity, short attention span, impulsive behaviour, and distractibility. Some of the physiological theories of ADDH emphasize an abnormal level of arousal as a principal underlying factor. Satterfield, Cantwell and Satterfield (1974) offered the hypothesis that hyperactive children are under aroused, in that they show a greater amount of slow-wave activity in their EEG and a lower level of skin conductance, relative to normal children. Low CNS arousal level is proposed to result in a lack of inhibitory control and the appearance of distractibility. This theory has been useful in accounting for the seemingly paradoxical fact that stimulant drugs, most prominently methylphenidate hydrochloride are effective in about 70% of children in controlling hyperactive behavior (Abikoff and Gittleman, 1985). Apparently, the stimulants increase the level of arousal back into the normal range.

Schizophrenia has also been linked to hyperarousal. Investigators have established that acute schizophrenics maintain a higher-than-normal level of autonomic arousal as seen in higher
heart rates (Gjerde, 1983). Another indication of high chronic arousal in schizophrenics is the fact that they take so long to habituate to repetitive, non-meaningful stimuli like a bell that sounds every 60 seconds.

But hyperarousal alone does not explain the problem of schizophrenia. Blood flow patterns in the brain area reveal that schizophrenics appear to have too little activity in the frontal lobes and too much in the temporal regions. EEG data agree with these findings; unusually slow brain waves (delta) are dominant in the frontal lobes of schizophrenics. Beta waves, indicative of arousal, are strong only in parietal and temporal lobes (Morstyn et al., 1983). Thus, the schizophrenics attention disorder may be the result of both hypoarousal in the frontal lobes and hyperarousal in the posterior cortex.

Two more mood disorders – depressive disorder and bipolar disorder, are also due to disturbances in the optimal level of activation. In depressive disorder, the person often enjoys a normal range of activation (i.e. from quiet to excited) but has periods during which activation level gradually falls to a
depressed level and stays there for days or weeks before it rises again. During depressed periods, there is a total loss of interest in people or events. Although the person feels restless and agitated, there seems to be too little energy to accomplish even the simplest task.

The "poles" in bipolar disorder are the opposite extremes on the activation continuum: mania at one end and depression at the other. It involves episodes of extremely high activation (mania) usually alternating with periods of depression. The depression of the bipolar disorder is much like that of depressive disorder. In the manic phase of the bipolar disorder, the patient may be overactive, expansive, irritable and over talkative. Tremendous energy is displayed, and ideas appear to come too fast to allow time for expressing them all.

Another problem which can be due to disturbed arousal condition is epilepsy. It is a collection of different brain dysfunction symptoms all involving seizure activity. A seizure is a brain state involving the organization of a massive number of
neurons into patterns of abnormal activity. The most outstanding feature of seizure activity is hypersynchrony.

Hypersynchrony refers to a condition in which there is too much simultaneous facilitation. There are too many Excitatory Post Synaptic Potentials (EPSPs) occurring together at the same time. The high amplitude EEG waves characteristic in an epileptic seizure imply that literally millions of neurons are firing together in gigantic volleys. Such waves are usually accompanied by total loss of consciousness. The huge waves of a seizure suggest that neurons that would normally participate in patterns of activity underlying thoughts or percepts are being forced to fire in giant groups that represent nothing at all, that convey no meaning because they are assembled by some defective internal process rather than by meaningful external or internal events. In other words, seizure waves contain no information; they are nonsense events and are therefore unable to produce a conscious state.

The fact that arousal has been related to behaviour, as well as to two different categories of physiological processes (ANS
activity and activity of the BSRF), led to the distinction of three different kinds of arousal — behavioural arousal, autonomic arousal and cortical arousal — a distinction to which temperament researchers often refer (e.g. Buss & Plomin, 1984). There are, however, other categories of arousal. For example, Routtenberg (1968) made a clear-cut distinction between two systems of arousal: Arousal System I, which refers to the BSRF, and Arousal System II, which is located in the limbic system. Arousal System II, as distinguished by Routtenberg, cannot be identified with ANS arousal. Rather, Arousal System II is regarded by Routtenberg as a reward system. Gray (1982a, 1982b) also referred to the reward function of the limbic system when studying the biological basis of temperament.

**ACTIVATION AS A PHYSIOLOGICAL DESCRIPTOR**

“Arousal” is said to occur when phasic physiological (central and autonomic) or behavioural responses following sudden and unexpected changes of sensory stimuli have taken place. Neural circuits hypothesized to constitute the “arousal
system” extend from the spinal cord through the brain stem reticular function, including hypothalamic sites. Forebrain control over this core-brain “arousal system” is exerted by reciprocal facilitation and inhibition by amygdaloid centers. The “activation system” prepares the organism to respond; it is hypothesized to be located in the basal ganglia. The “effort system” comprises the hippocampal circuit; it is involved in uncoupling stimulus and response. Without such a mechanism “behaving organism would be constantly aroused by their movements and moved by arousing inputs” (Pribram & Mc Guinness, 1975).

Some researchers have drawn a distinction between arousal and activation. This distinction has been very clearly spelt out by Eysenck. According to Eysenck’s (1967) view, individual differences in the level of activity in the corticoreticular loop determine the individual’s position on the extraversion – introversion dimension. When he referred to activity of the corticoreticular loop, Eysenck used the construct “arousal”; the most direct physiological index of arousal is EEG activity (Eysenck, 1970, 1991; Eysenck & Eysenck, 1985). In contrast,
the physiological basis underlying neuroticism (emotionality stability) is located in the visceral brain, which controls ANS activity. In contrast to the activity of the BSRF, the activity of the visceral brain, "which produces autonomic arousal" (Eysenck, 1991) has been labeled as "activation" (*Eysenck, 1991; Eysenck & Eysenck, 1985). The fact that extraversion and neuroticism seem to be orthogonal to each other also influenced Eysenck's thinking about the relation between the two systems that determine the levels of arousal and activation. Unless high activation occurs, "these two systems are independent" (Eysenck, 1991).

Thus, Eysenck's distinction between anatomical and physiological differentiation of arousal and activation is rather clear. However, the difference between the two concepts becomes less clear when their measurement indices are considered. When he measured the physiological correlates of extraversion, Eysenck used typical indices of cortical arousal such as EEG activity, evoked potentials, and contingent negative variations. But he, as well as others, also used visceral brain
measures, which are considered as indices of the level of activation e.g. indices of EDA have been used in studies on extraversion (Stelmack, 1990; Stelmack & Geen, 1992). Similarly, Eysenck (1991) considered a finding by Wilson (1990), which showed predicted differences in daily tonic skin conductance changes for introverts and extraverts, as one of the strongest arguments in chronic arousal between extraverts and introverts. The argument that Eysenck used to allow such measures as EDA, secretion of salivary glands, and pupillary dilation to be considered as indices of arousal is as follows. The activity underlying these measures is fully under the control of the central nervous system. The corticoreticular loop also controls ANS activity (Eysenck, 1991; Stelmack, 1990). Using this argument, one can conclude that all, or almost all, nervous and endocrine processes are under the control of the cortex or other higher nervous centers. By taking such a position, which is showed by many researchers (Gale and Edwards, 1983; Gunnar, 1990; Stelmack & Geen, 1992; Zuckerman, 1991), it is almost impossible to distinguish between physiological concepts that are
typical for extraversion and those that are typical for neuroticism. This is also true for other traits of temperament.

THE REGULATIVE THEORY OF TEMPERAMENT

In Strelau’s (1974, 1983, 1985) regulative theory of temperament, the optimal level of arousal is considered as a standard for stimulation regulation (Eliasz, 1981; Strelau, 1983). The concept of optimal level of arousal explains the role that temperament activity plays in regulating the energy level of behaviour and the situation in which behaviour occurs.

Strelau’s concept of the energy level of behaviour, included all those traits associated with individual differences in physiological mechanisms responsible for the transmission of energy, including both the accumulation of energy and its release from store. Included are certain features of the endocrine system, the autonomic nervous system, nervous systems in the brain stem (especially the ascending reticular activating system), and finally, properties of the neo-cortex which reflect its collaboration with lower brain centers and the endocrine system in the regulation of
excitation or activation. These systems work together in an integrated fashion, forming a functional unit which has a fairly stable structure. The interactive properties of these systems are the basis of stable properties of temperament. This neuroendocrine unit, while it functions as a system, has within it nevertheless, sub-units which vary in their level of functioning and it is such variability which accounts for partial differences observed in particular temperamental traits (Nebylitsyn, 1972; Strelau, 1972).

Two basic temperamental features are distinguished in relation to energy level: reactivity and activity. Reactivity is conceived here as a property responsible for a relatively stable intensity of response to stimuli; this is estimated on a comparative basis, comparing each individual against a data set derived from a group, expressing the magnitude of the individual’s response in relation to others’ response to the same stimulus. The assumption here is that the stimulus administered has a similar value for all persons or is neutral in volume. Reactivity is a co-determinant of sensitivity, as measured by
sensory threshold and the organisms capacity for work (its endurance), as manifested in reactions to strong and/or prolonged stimulation. The weaker the stimulus which elicits a perceptible response (the higher the sensitivity) and the weaker the stimulus which starts to lower efficiency (the lower the capacity), the higher is the reactivity of the individual, and conversely a low reactive person is marked by low sensitivity and high endurance.

This means that certain stimuli received from the outside world as well as from within the organism, evoke stronger responses in high reactives than in low reactives. Matysiak (1980) opined that high reactives have a high stimulation processing co-efficient (SPC). On the other hand, low reactive individuals have a physiological mechanism which suppresses stimulation, so that stimuli of a known physical strength elicit a lesser reaction then they do in high reactives. Thus low or weakly reactive individuals have a low SPC.

The second factor relating to behavioural energy is activity, which is conceived of as a property determining the amount and range of actions undertaken which have a given stimulatory
value. According to this concept, an individual supplies him or herself with stimuli until attaining an optimal level of arousal. Where stimulation and arousal are above optimum, the individual is motivated to engage in activities designed to reduce it to the optimum. During ontogenesis the need to maintain an optimal level becomes a sort of need in its own right. Disturbance of this equilibrium initiates motivation to act in such a way as to ensure a return to optimal level and to maintain that level.

High reactive individuals, in whom the physiological mechanism is marked by a high SPC, have a low need for stimulation to attain optimal activation. On the other hand, low reactive individuals, having a low SPC, provide themselves with a larger number of stimuli to maintain the optimal level of activation and thus they show a high need for stimulation. Therefore, highly reactive individuals avoid situations and activities which involve strong stimulation, while low reactive persons undertake activities and seek out situations which possess a high stimulating quality. In consequence, weakly reactive
individuals one generally more active, while highly reactive ones show lowered activity.

In his extensive studies on the dependency between reactivity and intensity of stimulation in the natural environment, Eliasz (1981) found among other things, that adults who live in highly stimulating regions of large cities (considerable noise and traffic) are marked by lower reactivity in comparison with people who live in minimally stimulating suburbs (little traffic, peacefulness).

AROUSABILITY AS A CONSTRUCT UNDERLYING THE SEARCH FOR LINKS BETWEEN DIFFERENT DIMENSIONS OF TEMPERAMENT

Strelau (1994) was of the view that if one assumes that temperament traits are characterized by some degree of stability, then one must also assume that the physiological mechanisms of arousal, to which many dimensions of temperament refer, must also show some degree of stability. The CNS construct that fulfills this criterion is arousability. Gray (1964) introduced this concept to underline the two following statements: (a) there are
individual differences in the organismic determinants of arousal; and (b) because of these determinants, individuals have a chronic (more or less stable) level of arousal, which may be also called arousal trait. The relation between (cortical) arousal and arousability, accordingly to Gray (1964) is as follows:

Individual differences in arousability are such that individuals low on this dimension respond to stimulation with relatively low degrees of nonspecific reticular bombardment of the cortex, whereas individuals high on this dimension respond to stimulation with relatively high degree of such bombardment.

Gray (1964) limited his considerations of arousability to the concept of cortical arousal, as related to the strength of the central nervous system. Strelau (1994) proposed to use the term arousability as a broader construct. Whatever the mechanisms that regulate the level of arousal, individual differences in their functioning occur, and they reveal themselves in the fact that in some individuals stimulation of a given intensity \((S_n)\) results in a higher level of arousal \((A_{n+x})\), whereas in others, the level of
arousal to the same intensity of stimulation is lower \((A_{n-x})\). This might be expressed as follows:

\[
S_n \rightarrow A_{n+x} = \text{high arousability, whereas} \\
S_n \rightarrow A_{n-x} = \text{low arousability}
\]

---

**Figure 1.1**

**A strong case for arousability as a temperamental trait:**

Where, \(L_1\) --- General Arousal-Basal (1.5)

\(L_1 \rightarrow L_2\) --- State Arousal caused by \(St_1\) for \(t\) time

(1.5 to 1.7)

\(t_1\) --- time taken to reach to \(L_2\) from \(L_1\) after \(St_1\)
People differ in the placement of $L_1$ on general arousal state scale. High arousability implies higher placement. People also differ in their reactivity by shifting from $L_1$ to $L_2$ due to $St_1$. High arousability implies higher shift, i.e., greater and intense excitation (reactivity). People also differ in terms of quickness with which they react despite same $L_1$ and same $L_1 - L_2$ enhancement. High arousability indicates shorter $t_1$, i.e., time gap to reach $L_2$ from $L_1$. Similarly people may also differ in terms of $t_2$ i.e., time taken to return to $L_1$ from $L_2$.

In accordance with the concepts of arousal and activation as applied in temperament research, the indices of arousability may be of different kinds: behavioural characteristics (in correspondence with behavioural arousal), reactions referring to the activity of the ANS (autonomic arousal) or visceral brain (visceral arousal), as well as indices of EEG activity (Cortical arousal).
Among the dimensions of temperament that are derived from different theoretical conceptualizations, a whole range of traits that refer to the construct of arousal may be mentioned. Researchers differ, however, in their views regarding the importance of the diversity of physiological, biochemical, and/or anatomical components taking part in determining the level of arousal. The following systems and/or components may be mentioned as the most important in regulating the level of arousal: the cortex, the reticular formation, the limbic system, the ANS, neurotransmitters as well as their enzymes, and hormones.

The dimensions of temperament that can be interpreted in terms of the concept of arousability can be extraversion – introversion, neuroticism, emotionality, sensation seeking, strength of excitation, reactivity, anxiety, impulsivity, augmenting – reducing, inhibited – uninhibited temperament and approach – withdrawal. The hypothesized biological mechanisms underlying these dimensions are as follows:

**Extraversion**: Differences in the level of activity in the corticoreticular loop determine the individuals position on the
extraversion – introversion dimension. Introverts are chronically more cortically aroused than are extroverts (Eysenck & Eysenck, 1985).

**Neuroticism**: Eysenck & Eysenck (1985) were of the view that 'people who are high in neuroticism produce activity in the visceral brain (i.e. activation) more readily than those low in neuroticism.

**Emotionality**: Buss & Plomin (1984) were of the view that emotionality which includes three basic emotional traits (distress, fear, and anger), is mediated by arousal of the ANS. Inherited individual differences in this system are thought to explain an essential part of the variance in emotionality. Individuals who are high in emotionality are chronically more highly aroused compared with individuals who are in a low position on this dimension.

**Sensation Seeking**: Individual differences in sensation seeking, which were primarily interpreted by Zuckerman (1984) in terms of the corticoreticular loop, have recently been treated as being determined by the activity of the neurotransmitters (dopamine,
nor epinephrine and serotonin) that are most prominently located in the limbic system. The biochemical factors determine the sensitivity of the neural system in such a way that sensation seekers are chronically less aroused than are sensation avoiders (Zuckerman, 1984).

**Strength of the nervous system**: According to Gray (1964) the individual’s position on the strength dimension may be explained in different ways that are not necessarily contradictory to each other, that is, by individual differences: (a) in the brain stem’s sensitivity to stimulation, (b) in sensitivity of the cortex to reticular activation, or (c) in the amount of epinephrine release in the reticular formation.

**Reactivity**: There exist not only inter but also intraindividual differences in the physiological arousal mechanisms that are responsible for codetermining reactivity; thus, the concept of “neurobiochemical individuality” seems to be most relevant. In high reactive individuals, this complex of physiological mechanisms enhances (augments) stimulation (whether external
or internal). In low-reactive individuals, these mechanisms reduce/suppress stimulation.

**Anxiety**: Gray (1982) concluded that the functioning of the septohippocampal system regulates the level of anxiety. Functionally, this system constitutes the behavioural inhibition system (BIS), which is composed of the three following structures: the hippocampal formation, the septal area, and the Papez circuit (Gray, 1991). BIS has the status of a CNS construct. Gray (1991) considered individual differences in operating parameters of the BIS (e.g., thresholds or case of excitation) as the basis for individual differences in anxiety.

**Impulsivity**: Impulsivity, regarded by Gray (1983, 1991) as one of the most basic temperament dimensions, has its biological basis in the behavioural approach system (BAS; also a CNS Construct). Gray (1991) hypothesized that the key components of this system are the basal ganglia, the ascending dopaminergic fibers of the mesencephalon (which innervate the basal ganglia), thalamic nuclei, and neocortical areas. Analogous to the BIS, individual differences in operating parameters of the BAS have to
be considered as the basis for individual differences in impulsivity. Schalling and Asberg (1985) argued that the physiological mechanism of impulsivity lies in the limbic – frontal connections, the sensitivity of which is modulated by the monoamine neurotransmitters.

**Augmenting Reducing** : Petrie (1967) who introduced the augmenting – reducing dimension, hypothesized that there exists a central stimulus intensity control mechanism, which is probably the general nonspecific arousal system. Buchsbaum (1976), who also used the concept of augmenting reducing in studies on evoked potentials, interpreted this dimension in a way that was opposite Petrie’s original view. Buchsbaum (1976) argued that three types of neural pathways may be responsible for the individual differences in augmenting – reducing : ascending inhibitory, nonspecific arousal, and cortical – cortical.

**Inhibited – Unhibited Temperament** : The two temperaments distinguished by Kagan and co-workers (Kagan, 1989; Kagan, Reznick & Snidman, 1988) are supposed to be qualitatively different on the behavioural level. However, Kagan (1989)
assumed that, in their physiological basis, the two temperaments differ quantitatively. The biological basis of inhibited temperament consists in “lower (as compared with uninhibited individuals) thresholds of reactivity in the limbic system, especially the amygdala and hypothalamus” (Kagan, 1989).

**Approach/Withdrawl**: A good starting point for hypothesizing some biological mechanism underlying this temperament dimension is the approach – withdrawl intensity hypothesis, as developed by McGuire and Turkewitz (1979). According to this hypothesis, the threshold of approach behaviour occurs when stimuli are at lower intensity levels, compared with the withdrawl threshold. If one assumes that (a) intensity is defined in terms of the amount of normal activity and (b) individuals differ in the tendency to approach or withdraw from new situations, then one may hypothesize that there exists a physiological mechanism that mediates the intensity of stimuli. Because withdrawl and approach responses are accompanied by changes in motor tension and by changes in the cardio-vascular system, as illustrated by McGuire and Turkewitz (1979), it is highly probable that
components of the limbic system produce arousal and explain individual differences in approach—withdrawal behaviour.

Synthesis: Emergence of Arousalability as a temperamental trait

All of the just mentioned dimensions or categories of temperament refer to neurophysiological and/or biochemical mechanism of arousal. This means that, in spite of the differences in their psychological content as well differences in their physiological interpretation, one may assume that they refer to a common phenomenon, that is, to arousability. A presumption is made (explicitly or implicitly), which is valid for all of these dimensions, that there exist more or less stable individual differences and/or biochemical mechanisms that explain the individual differences in temperament traits.

Strelau (1994) was of the conviction that by using the NS construct of arousability, it is possible to integrate research on temperament traits stemming from different biologically oriented theories, or at least possible to throw some light on the links between those characteristics of temperament.
Objective of the Study

This is the point where the rationale for the present study comes in. Arousability has been envisaged as a kind of super trait capable of explaining individual differences in a variety of phenomenon. The present research is an attempt to identify these individual differences empirically.

Construct validation requires the gradual accumulation of information from a variety of sources. Constructs and the attempts at validating them are central to the scientific endeavour of psychology. Constructs are the inductive summaries of the empirical knowledge and at the same time the building blocks of theories. They are necessarily open concepts, open with respect to their referents or indicators, other related constructs, and the underlying real entity, if such can be reasonably stipulated. Thus, the investigation and elaboration of the homological network in which a construct is embedded is carried out and advanced by the process of construct validation.

In a thoughtful analysis of construct validation, D.T. Campbell (1960) pointed out that, in order to demonstrate
construct validity, we must show not only that a test/index correlates highly with other variables with which it should theoretically correlate, but also that it does not correlate significantly with variables with which it should differ.

Although correlation is an important technique for construct validation, the difficulty of research which aims to discover the nature of the basic temperamental properties by correlated indices is increased by the fact that one and the same index may be dependent on two or more temperamental traits. This circumstance makes the results of factor analysis especially useful in a mathematical treatment. Alongwith other techniques, factor analysis is a specific technique that is particularly relevant to construct validation. Essentially, factor analysis is a refined statistical technique for analysing the inter-relationships of behaviour data.

Hence the present research aims at the construct validation of arousability as a temperamental trait – through factor analysis utilizing a variety of physiological and psychometric measures implying – Eysenckian Personality/temperamental dimensions,
Strelau’s Pavlovian Temperamental dimensions, Rusalov’s Temperamental dimensions, Mehrabian’s Trait Arousability and Matthews Mood dimensions along with measures of cardiac, muscular and skin conductance.