

## Temperament traits, and what are they based on

Families with two and more kids know that these children were different from the day they were born, and there is something biological, fundamental that makes them different. These biologically-based differences are called *temperament*. Temperament is not the same as personality, as personality develops with children's establishment of social relations, their sharing of family and cultural values, attitudes and skills. Temperament, however, is observed in very young infants, before any cultural influence, and also in animals. Animal breeders know this well. The question is – what traits does temperament consists of, and what are their biological bases? The Functional Ensemble of Temperament (FET) theory comes from psychophysiology and neurochemistry and that temperament has 12 components (traits) related to how people orient, initiate and maintain their actions, as well as to their emotional regulation (Fig. 1). Traditionally, psychologists separate traits related to the energetic (“Activity”) aspects (the ways in which an action is constructed, top 3 rows, 9 traits) and to Emotionality (ways of reaction, the bottom row, 3 traits).

|                                                  |  | Functional aspects of behavior:                                                  | Behavioral orientation to types of reinforcers:<br>(NE+...)                                                                    | Dynamical aspects<br>Preferred speed of integration of actions (DA+...)                                                            | Energetic aspects:<br>The ability to sustain prolonged and/or intense activities<br>(ACh, 5-HT+...)                                                |
|--------------------------------------------------|--|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Regulation of Actions<br>(Activity-construction) |  | Implicit, more probabilistic,<br><b>Mental aspects</b>                           | ... to learning causality and probabilities of events<br><u>Sensitivity to Probabilities</u><br>NE+DA+ACh                      | (in generation of new behavioral programs in changing situations)<br><u>Plasticity</u><br>DA+5-HT                                  | (Attention)<br><u>Intellectual (Mental) Endurance</u><br>NE, ACh                                                                                   |
|                                                  |  | Explicit, more deterministic:<br><b>Social-verbal aspects</b>                    | ...to others people's motivation<br><u>Empathy-autism</u><br>NE+OXY, VSP                                                       | (speed of pre-learned social-verbal elements of actions)<br><u>Social Tempo</u><br>DA+ PRL, OXY                                    | (Sociability)<br><u>Social-verbal Endurance</u><br>5-HT+NP, OXY                                                                                    |
|                                                  |  | <b>Physical-motor aspects</b>                                                    | ...to physical sensations and HPA arousal<br><u>Sensation Seeking</u><br>NE+NPY/SubP                                           | (speed of using pre-learned physical elements of actions)<br><u>Motor-Physical Tempo</u><br>DA+PRL+NP                              | <u>Motor-Physical Endurance</u><br>5-HT+ACh, NP                                                                                                    |
| Regulation of Reactions<br>(Emotionality)        |  | Emotional amplifier /appraisal of orientational, dynamical and energetic aspects | Low tolerance of uncertainty and novelty, negativity bias in expectations<br><u>Neuroticism</u><br>KOPr? NE-HPA<br>KOPr > MOPr | A degree of how premature is an integration of actions, emotional reactivity<br><u>Impulsivity</u><br>DOPr? (DA, MOPr, BDNF, CREB) | A tendency to be (sometimes overly) optimistic /confident in one's own capacities<br><u>Self-confidence</u><br>MOPr? (5-HT,DA)<br>MOPr > KOPr, SOM |

Fig. 1. The Functional Ensemble of Temperament model of the links between temperament traits and neurotransmitter systems. Bold shadowed text highlights the names of temperament traits. Blue font highlights neurotransmitter systems. Note: 5-HT: serotonin; DA: dopamine; NE: noradrenalin; ACh: acetylcholine; GH: Growth Hormone; SOM: Somatostatin; PRL: prolactin; OXY: oxytocin; SubP: Substance P; NPY: Neuropeptide Y; KOPr, MOPr, DOPr: kappa-, mu- and delta-opioid receptors correspondingly.

These 12 temperament traits, or aspects of behaviour, were linked to specific chemical systems in the brain (“neurotransmitters”), that regulate how energetic, or emotional, or focused, or flexible, or

risk-taking, or empathic people are in their behaviour. It is important to note that the production, exchange and decomposition of neurotransmitters are the main ways in which the brain regulates our behaviour. There is nothing in the brain that is free of this neurochemistry. If we want to learn what makes people perform differently the very same action in the very same situation, then we have to look at differences in their brain neurochemistry. It appears that the brain has many types of neurotransmitters, hormones and neuropeptides that affect our behaviour in specific ways. What complicates the study of these systems is that these neurotransmitters do not have a “1 chemical = 1 trait” arrangement, as was initially thought. Instead, it is a combination of neurotransmitters whose “team action” shows up as a temperament trait, and these teams overlap and interact with each other in the regulation of several traits. That is why FET theory uses the word “ensemble” and groups the traits in the 3 x 4 matrix, showing which neurotransmitter leads the teams in each column. Moreover, the location of various neurotransmitter systems in the brain matters in how they regulate our behaviour. For example, temperament traits regulating our behaviour in complex situations, requiring mental control and intelligence (top 3 traits in the FET model) are based on brain regions located in the frontal cortex, and the traits regulating our automatic behaviour, or actions in known situations, are based on middle-brain neurotransmitter systems (3 physical traits in the FET model).

Weak imbalances in these neurochemical systems cause what we see as “special characters”, or temperaments in people. However, these imbalances can be rather big and make regulation of behaviour difficult: a person might feel too weak, or too rigid, or unable to focus and feel love and attachment, or might be too anxious, too impulsive or too overconfident and risky. When these imbalances are so strong that people can’t work or study, or have problems in their personal life, then we are talking about mental disorders and a possible need for medications to restore these imbalances. In this sense temperament and mental illness are based on the same neurotransmitter systems but represent different degrees of imbalances. Temperament occurs in practically all healthy people, just in different “flavours” of consistent behavioural differences; mental illness occurs only in a small portion of the population and reflects strong imbalances in the brain neurochemistry.

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## **Publication**

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