A Map of Human Temperament to the Calendar Year

RUNNING HEADER: A MAP OF HUMAN TEMPERAMENT

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A model is proposed where, in addition to the previously established human behavioral patterns tracked to the annual sunlight-driven dopamine cycle or seasonal pattern, a second dopamine "clock" is proposed in the human brain. This clock-cycle involves a wavelength of 40.5 days (approximately 1/9th of a 365 day calendar year) starting at the winter solstice on December 21. This cycle is measured in this proposal starting with a 13 to 14 day-long concave dopamine peak with hyperactive and impulsive temperament, diminishing to a 13 to 14 day-long period of calm and focus, and ending with a 13 to 14 day-long convex phase with increased anxiety and depression, after which the cycle begins again. These two cycles are considered as the only factors needed to map an aggregate annual calendar of human temperament.

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

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A Map of Human Temperament to the Calendar Year

A model is proposed where, in addition to the previously established human behavioral patterns tracked to the annual sunlight-driven dopamine cycle or seasonal pattern (Figure 1), a second dopamine "clock" is proposed in the human brain. The speculated clock-cycle involves a wavelength of 40.5 days (approximately 1/9th of a 365 day calendar year) starting at the winter solstice on December 21. This cycle is measured starting with a 13 or 14 day-long concave dopamine peak with hyperactive and impulsive temperament, diminishing to a 13 to 14 day-long period of calm and focus, and ending with a 13 to 14 day-long phase with increased anxiety and depression, after which point the cycle begins again (Figure 2).

Methods

Over a period of three years, three adult males in their forties were tracked on a daily basis measuring subjective values of temperament. The subjects included a bipolar individual with ADHD and a benign essential blepharospasm, an individual with only ADHD, and a control individual with neither. Changes in medication, behaviors (exercise, focus, creativity, quality of sleep) and blepharospasms (in the bipolar subject) were monitored to attempt to isolate a possible reoccurring calendar pattern or cycle inherent to all humans i.e., an additional cyclic pattern of, yet to be discovered, fluctuating dopamine levels that could help explain behaviors in the aggregate human populations. A pattern was observed in all three subjects with the severity of the effects diminishing from the bipolar subject, the ADHD, and control subject. The observed pattern was of the noted spike-and-drop sloping temperament function that had a reoccurring pattern of 40.5 days year-over-year. The specific intervals of the combined peaks of these two dopamine cycles on a calendar graph thus specify windows of significantly increased hyperactivity and impulsivity and thus possibly even predictable timeframes for increased violent, aggressive, and spending behaviors in the human population (Figure 3 and Figure 4).

The observations in this informal study and prior literature were used to create a year-long calendar model where the dopamine sinusoidal wave pattern (Maruani et al, 2018), tied to blue light from sunlight, was overlaid with the 40.5 day wavelength to create an aggregate map of human temperament (Figure 4).

The premise driving this study was that the severity and timing of blepharospasm events of the bipolar subject, likely increased by ADHD medications, might indicate a subtle dopamine cycle (vis a vis a dopamine level “stress test”) that would become visible via the amplification of dopamine levels in a subject with bipolar and on dopamine boosting ADHD meds. This pattern would otherwise get lost in the "noise" of variations in mood from everyday life events and exogenous factors listed as limitations to this work.

Note that benign essential blepharospasms - the uncontrollable eyelid blinking and facial dystonias or “motor tics” i.e., the blink system - are sensitive to central dopamine levels (Evinger, 2013). Dopamine depletion alone is also noted as a cause of blepharospasm (Evinger, 2013). Evinger (2013) also noted that “abnormalities in dopamine transmission may be a proximate cause of the predisposing condition that allows the development of benign essential blepharospasm.” Abnormalities in the basal ganglia dopamine system are also noted as leading to abnormal sensorimotor mappings manifest as blepharospasms (Peterson DA and Sejnowski TJ, 2017). Abnormal dopaminergic signaling in the striatum of the human brain could also induce pathological reinforcement learning and lead to blepharospasms (Peterson DA and Sejnowski TJ, 2017).

The proposed additional 40.5 day dopamine cycle is speculated as being caused by a lag in the adjustment in eye retina size to seasonal changes, i.e., the pupil size is incorrectly sized too large or too small (thus leading to excessive or diminished dopamine levels from blue light) until the lag is adjusted to the proper pupil size for the given time of year after 40.5 days. Murani et al (2018) noted that "retinal anomalies are apparent in Seasonal Affective Disorder during the depressive phase in autumn/winter" (pg. 11). Murani et al (2019) also note in their research that:

> The photoperiod also alters the balance of dopamine. Dopamine acts to regulate the sleep/wake cycle. Dopamine is also important to adaptation to the light/dark cycles in retina photo-receptors (pg. 11).

Lack of sleep has been linked to poor impulse control and emotion dysregulation (McCarver-Reyes, 2019). McCarver-Reyes (2019) noted in their research that sleep deprivation was associated with impaired response inhibition, risky decision-making, increased risk-seeking, attention deficit hyperactivity disorder (ADHD), gambling disorder symptoms, Internet addiction symptoms, and personality-related impulsiveness.

Dopamine via its involvement in the sleep process, as well as directly, can influence impulsive and hyperactive behaviors. Katherine Harmon wrote that "impulsivity has long been linked to the neurotransmitter dopamine, which is involved in learning and reward" (pg. 1) in her July 29, 2010, article in Scientific American titled Dopamine Determines Impulsive Behavior: Brain scans illuminate the internal connection among the neurotransmitter, impulsiveness, and addiction.

Limitations to the method include the obvious small sample size leading to large assumptions and generalizations not backed by standard statistical regression analysis. Other limitations to the final proposed model include the lack of detailed tracking of many other factors that can influence human temperament and thus behavior.

The claim of the model is that only two dopamine associated cycles are needed to represent the vast majority of temperament of a given individual on a given day of the year which, at an individual level, may obviously not be accurate given the number of known other possible influences or factors. Those factors could include stress, travel, sleep apnea, low blood sugar or glucose levels, cloudy or stormy days, medications for blood pressure, SSRIs, sedatives, stimulants, tranquilizers, alcohol, illegal drugs, even day-light savings interruptions to sleep, time of day, physical or psychological trauma, medical conditions like rapid-cycling bipolar disorder, and even oxytocin (i.e., emotional love) or heartbreak related depression.

Additional limitations include estimates made for the scale of change and the relative or comparative weights of the cycles, or between comparisons of cycles, created by subjective data and analysis.

Census, sociology, Big Data, and criminal justice groups would be urged to regress this model with their large year-over-year, and larger, data sets to find additional granularity and possibly additional contributing factors. Scientists, researchers, and medical professionals can work to confirm the number of dopamine cycles in the human brain via Big Data supercomputing top-down analysis as well as via f-MRI or PET brain scans and laboratory blood and sleep testing to qualitatively validate the theorized 40.5 day dopamine cycle. The days or weeks in the model when there are dual reinforcing peaks from both of the dopamine cycles should be compared against data sets of violent crimes, mass shootings, stock purchasing, heart attacks, consumer spending, consumer sentiment, etc.

Results

An analysis of the subjective data indicated a second dopamine "clock" in the human brain. This proposed clock-cycle involves a wavelength of 40.5 days (approximately 1/9th of a 365 day calendar year) starting each year at the winter solstice on December 21. This cycle is measured in this proposal starting with a 13 to 14 day-long concave dopamine peak with hyperactive and impulsive behavior or temperament, diminishing to a 13 to 14 day-long period of calm and focus, and ending with a 13 to 14 day-long phase with increased anxiety and depression, after which the cycle begins again. This cycle, in addition to the seasonal (sunlight or blue light driven) dopamine cycle, are considered as the only factors needed to map an aggregate annual calendar of human behavior or temperament – at least in the United States or the northern hemisphere (Figure 3).

Knowing, a priori, the likelihood of one's temperament on a given day or week, one can adjust or "sanity-check" their decisions accordingly e.g., pause, seek advice, sedate, isolate, avoid spending, give the major speech, do the job interview, relax, or enjoy nature or the company of friends, etc.

Many colloquial experiences can actually be seen in the aggregate calendar of the two dopamine cycles in Figure 4. Once can observe lower scoring "winter blues" and the "dog days of summer." Note too how the October 31, Halloween holiday and the March 17, St. Patrick's Day holiday, both major United States holidays with large alcohol consumption, fall into impulsivity spiking windows.

The specific intervals of the combined peaks of these two cycles on a calendar graph thus specify windows of possible increased violent, aggressive, impulsive, and spending behaviors in the human population (Figure 4).

The effects of changes in environmental pollen levels were also noted with the inverse histamine and serotonin relationship as another key impactor to behaviors but only within their limited timeframes each year. While the sunlight driven dopamine cycle is generally understood, the additional proposed cycle likely has not been identified due to obfuscation from the seasonal pollen produced histamine and serotonin influences that have historically been underestimated in terms of their effect on individual and population temperaments and behaviors.

The biochemical mechanism behind the seasonal pollen and histamine cycles are mast cells in the human body that emit serotonin that is known as a mood-modifying molecule. Theoharides T. et al. (1982) noted in the journal Nature:

> Because of mast cell involvement in these clinical syndromes… there has been great interest in the pharmacological modulation of histamine release from mast cells. Serotonin is also stored in mast cell granules. Because histamine and serotonin may have divergent functions in delayed hypersensitivity, we hypothesized that these amines could undergo differential release. (p. 1)

Nautiyal, K. M. et al. (2012) in The European Journal of Neuroscience noted that:

> Mast cells are a source of serotonin. We conclude that mast cells contribute to behavioral and physiological functions of the hippocampus. It is known that mast cells can

> synthesize and store serotonin. The hippocampus is important in the regulation of anxiety and depressive behaviors. (p. 2)

Mentally unstable individuals can be triggered into impulsive and violent activities from spikes in serum serotonin (Cetin et. al., 2017). Serum histamine level is directly proportional to environmental allergen levels producing the obvious and dreaded seasonal allergic reaction symptoms. But serum serotonin level, or the body's control of the level, is inversely proportional to serum histamine levels (Hough, 1999, and Munari et. al., 2015, and Ryo et. al., 2006). It is also critical to note that male humans have fifty-two percent more serotonin than females (Nishizawa et. al., 1997).

Serotonin levels in the body also influence temperament and behavior indirectly via serotonin's role in sleep via melatonin synthesis. As Maruani et al. (2018) note "serotonin, which is derived from tryptophan via the enzymes tryptophan hydroxylase and 5HTP-decarboxylase, is acetylated by AANAT to form NAS (N-acetyl-serotonin), which is then methylated by hydroxyindole-O-methyltransferase (HIOMT), also called acetyl serotonin-methyltransferase (ASMT), to synthetize melatonin" (pg. 5).

Maruani et al. (2018) also note that bipolar disorder patients show:

> Alterations in pineal melatonin secretion, including hypersensitivity to light and decreased serum melatonin in both acute and euthymic bipolar disorder patients compared to healthy controls. Decreased serum melatonin and hypersensitivity to light have therefore been proposed as bipolar disorder. … Alterations in melatonin secretion

> may be an important driver of internal biological clock anomalies, contributing to the suboptimal adaptation to environmental changes, including seasonal (pg. 9).

Serotonin has thus been associated with Seasonal Affective Disorder temperament changes via its role with biological clocking with serotonin modulating the brain's suprachiasmatic nuclei (responsible for synchronizing biological behavioral and physiological rhythms) response to light (Maruani et al, 2018).

Spring and fall seasonal pollen (histamine) induced serotonin increases, as pollen levels fall, similar to dopamine, impact impulsive behavior in human populations as seen in United States mass shootings data between the years 2017-2021 (Figure 5). Thus, the optimal calendar graph or map of human temperament, as seen in Figure 6 and Figure 7, takes into account not only both of the dopamine cycles but also the spring and fall seasonal serotonin spiking cycles from seasonal pollen. Also note the convenient location or timing of winter Christmas holiday shopping dates like Black Friday after Thanksgiving - that occur during the large serotonin surge as ragweed pollen produced histamine subsides – perfectly timed to take full advantage of subsequent consumer spending impulsivity (Figure 7).

Discussion

The creation and verification of an actual cyclical temperament calendar has the possibility to be formalized into an actual mood or impulsivity gauge. Obviously, the amplitude of any given map would be more severe for bipolar individuals due to the blue light sensitivity. One can envision a smartphone application or "dashboard," akin to a pilot's altimeter or cockpit instrumentation, as seen in Figure 8, showing a daily or weekly "score" or meter (Figure 9 and Figure 10) as form of "temperamentometer." Note, that while the scientific community can monitor gravitational waves smaller than an atomic nucleus, we have comparatively very little tooling or visibility for real-time monitoring of dopamine and serotonin levels, and thus temperament, for a given individual. Progress is being made however, with current smartwatch technology now able to check metrics like blood pressure, pulse, and even blood sugar.

This proposal, while very speculative in nature and informal in presentation, is an effort to instigate additional focus in the direction of individual biochemical monitoring and feedback.

The claim of the work is that there are only three major factors (annual calendar neurotransmitter cycles) that play into an individual's temperament or impulsivity and that this temperament can be measured, scored, and predicted and, thus, help one to avoid sub-optimal impulsive actions and poor decision making. While advertising and marketing firms analyze Big Data related to aggregate consumer spending and sentiment data, this work proposes also examining behaviors and temperament from a biological basis.

A perfect long-term vision could involve nano-tech sensors inside individuals directly providing real-time feedback of dopamine and serotonin levels, and also external blue light and pollen levels, to help create an improved measure or score of an individual's temperament on a given day. Big Tech firms like Facebook or Google could even use their massive behavioral data stores and super-computing resources to examine human temperament or mood from texts and social media post text analysis to produce an optimal temperament assessment tool. This tool would allow an individual or party to know the likelihood of their own bias toward impulsive, emotional, or irrational action (or not) to allow proper assessment of factors (including their own state of mind) for better decision making. Consider the scenario where, if you knew that you are anxious on a given day, you can proactively move the date of your major speech. If you know you are at risk of impulsivity today, avoid the trip to the shopping mall or, from the vendor perspective, increase the number of advertisement buys.

Conclusion

While modern civilization in the 21st Century is still far from the societal behavioral prediction capabilities of a science like psychohistory envisioned by Isaac Asimov in his Foundation science fiction novels, the possibility should not be considered out of reach. High levels of dopamine and serotonin can both lead to impulsive behavior. The three primary causes of seasonal variations in dopamine and serotonin are considered as the primary factors in scoring human daily temperament. Thus, the two main points of this work involve a proposed additional 40.5 day-long dopamine brain clocking cycle and that an examination of this cycle, aggregated with the annual sunlight dopamine cycle and the seasonal pollen or serotonin cycle, can lead to a temperament map or calendar to predict individual and even aggregate societal behaviors.

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Figures

Figure 1

Primary dopamine cycle with shorter wavelengths in winter and longer in summer where temperament varies between Hyperactive – Impulsive, Normal – Calm – Rational, and Anxious – Depressed mental states and behaviors.

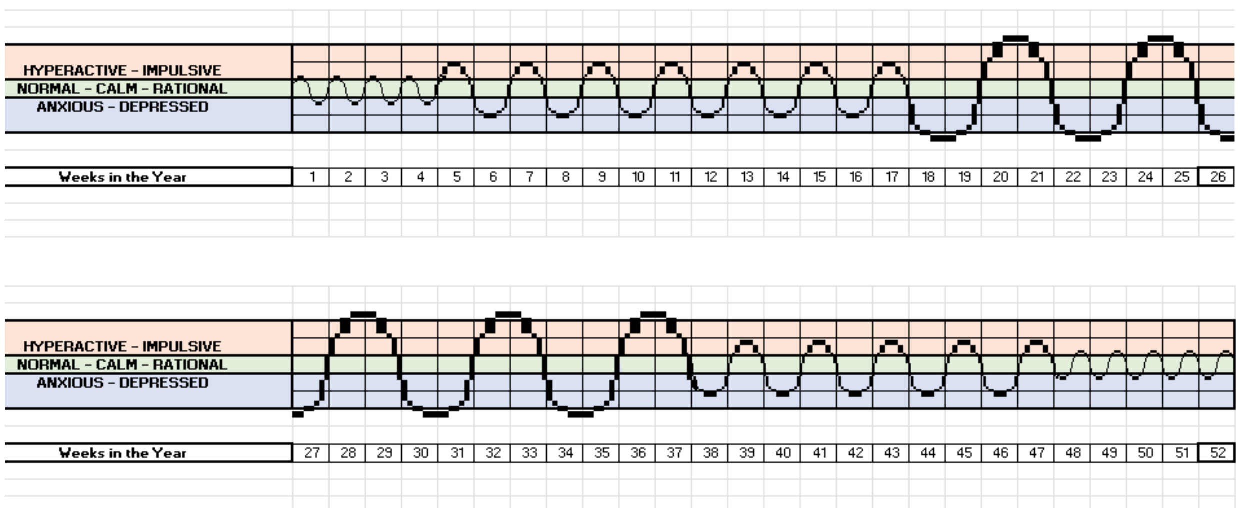
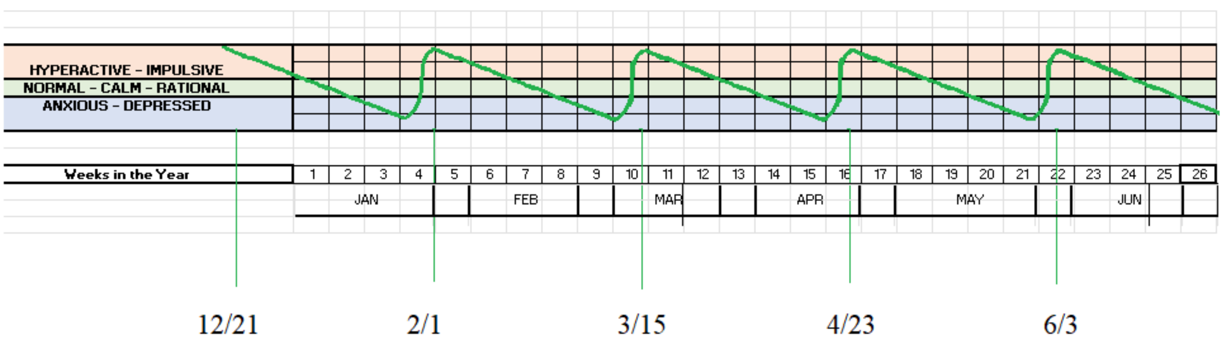


Figure 2

The proposed second dopamine clock-cycle involves a wavelength of 40.5 days (approximately 1/9th of a 365 day calendar year) starting each year at the winter solstice on December 21. This cycle starts with a 13-14 day-long concave dopamine peak with hyperactive and impulsive behavior or temperament, diminishing to a 13-14 day-long period of calm and focus, and ending with a 13-14 day-long phase with increased anxiety and depression, after which the cycle begins again.



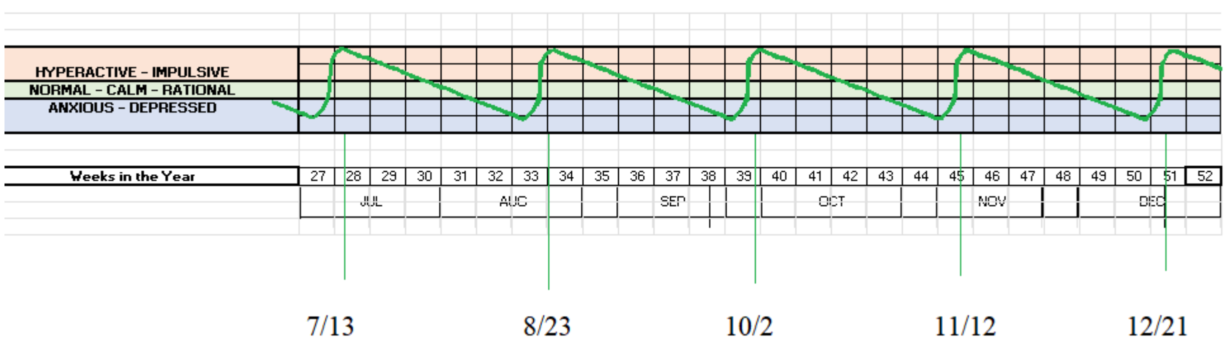


Figure 3

Combined graph of the dopamine sinusoidal annual wave with the additional proposed 40.5 day cycle showing the dates of the specific reinforcement peaks that become areas of concern vis a vis hyperactive and impulsive temperament and behavior.

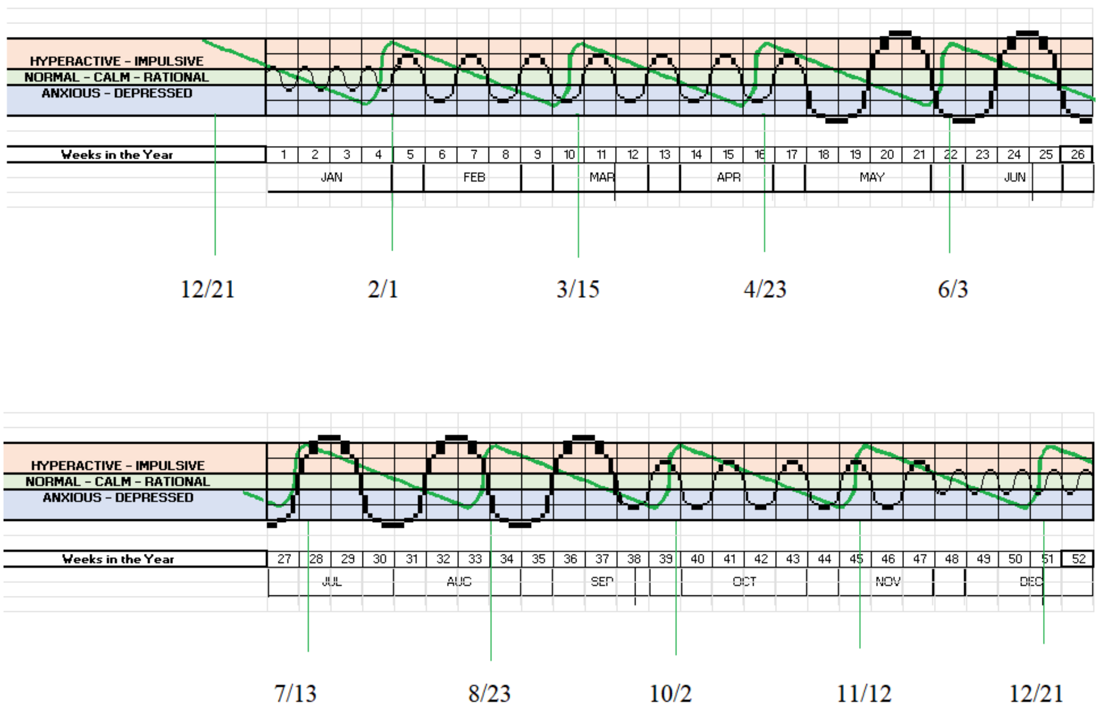
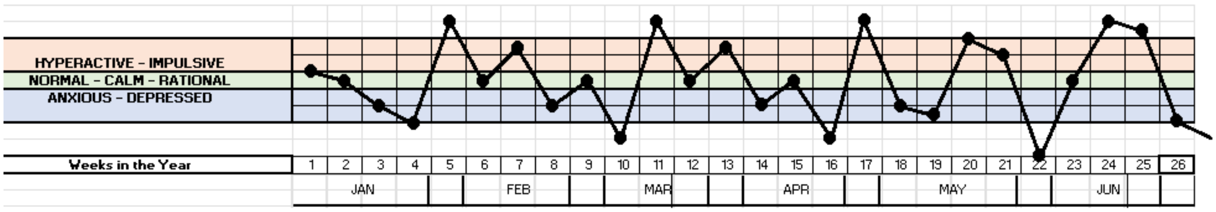
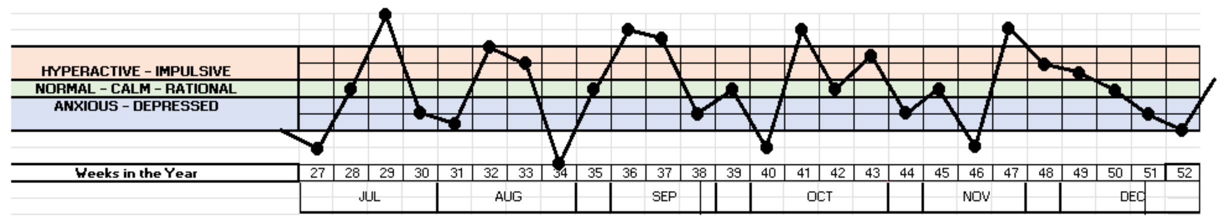


Figure 4

Aggregate summation graph from the values of the two dopamine cycles in Figure 1 and 2.



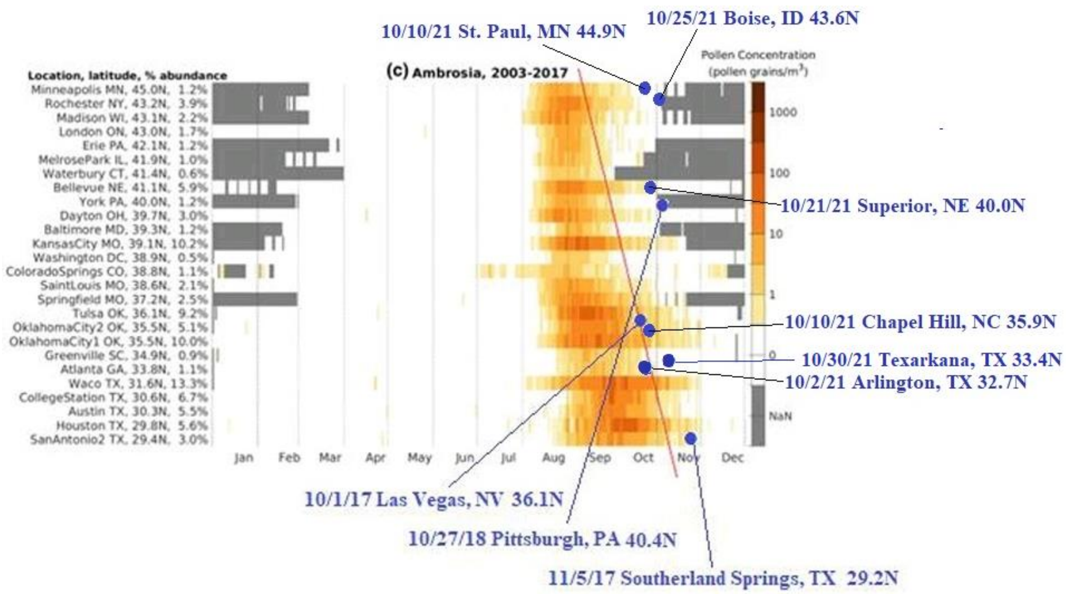
SCORE (mid week value)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
SINE = BLUE LIGHT	0	0	0	0	2	-2	2	-2	2	-2	2	-2	2	-2	2	-2	2	-4	-4	4	4	-4	-4	4	4	-4
BIPOLAR ANGLE	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0
TOTAL	1	0	-2	-4	6	0	3	-2	0	-6	6	0	3	-2	0	-6	6	-2	-3	4	2	-8	0	6	5	-4



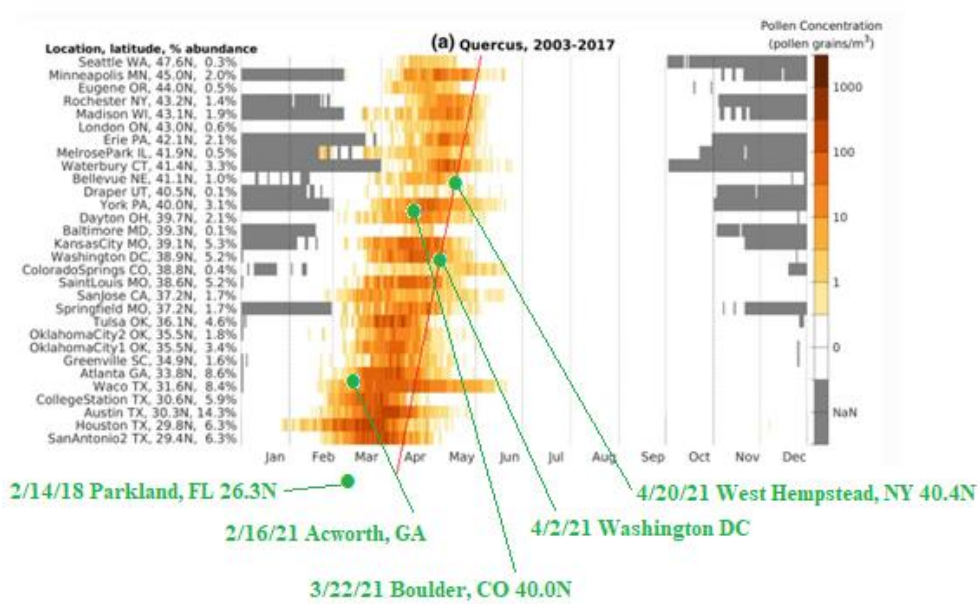
SCORE (mid week value)	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
SINE = BLUE LIGHT	-4	4	4	-4	-4	4	4	-4	-4	4	4	-2	2	-2	2	-2	2	-2	2	-2	2	0	0	0	0	0
BIPOLAR ANGLE	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4
TOTAL	-6	0	8	-2	-3	4	2	-8	0	6	5	-2	0	-6	6	0	3	-2	0	-6	6	2	1	0	-2	-4

Figure 5

Histamine induced serotonin changes that occur as pollen levels fall, similar to dopamine, impact impulsive behavior as seen in United States mass shootings data from 2017-2021. Fall (top) ragweed pollen levels by city ranked by latitude and Spring (bottom) tree pollen ranked by city ranked by latitude.



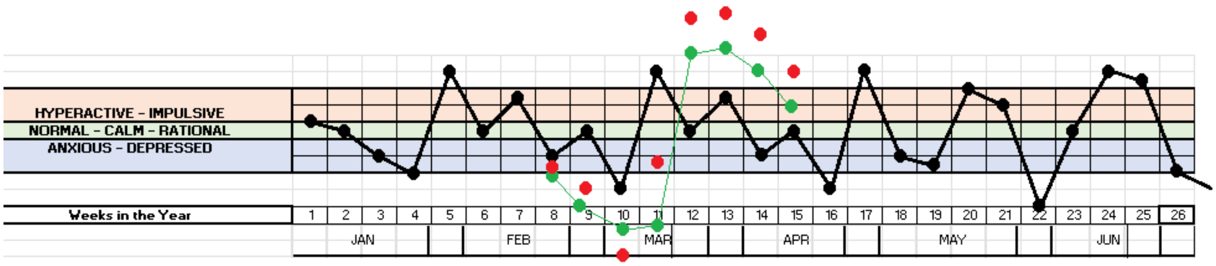
Source: https://link.springer.com/article/10.1007/s10453-019-09601-2



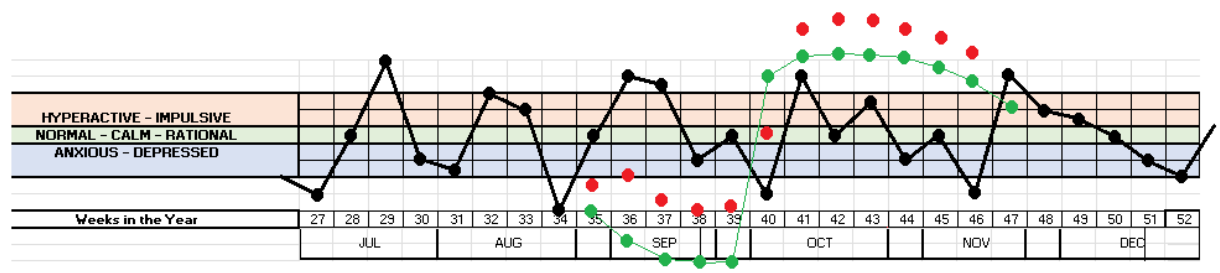
Source: https://link.springer.com/article/10.1007/s10453-019-09601-2

Figure 6

The aggregate dopamine cycles (black line) with the noted seasonal spring and fall pollen weeks with the green dots and lines representing the serotonin effects on temperament from tree pollen and the red dots the adjustment from combining the serotonin score with the dopamine aggregate score.



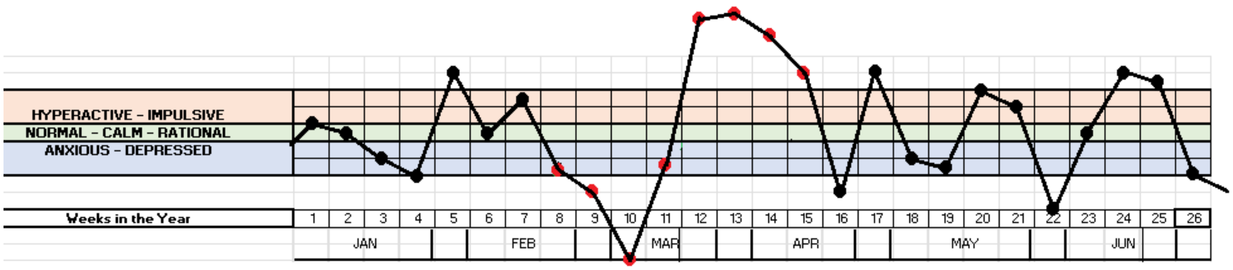
SCORE (mid week value)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
SINE = BLUE LIGHT	0	0	0	0	2	-2	2	-2	2	-2	2	-2	2	-2	2	-2	2	-4	-4	4	4	-4	-4	4	4	-4
BIPOLAR ANGLE	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0
TOTAL	1	0	-2	-4	6	0	3	-2	0	-6	6	0	3	-2	0	-6	6	-2	-3	4	2	-8	0	6	5	-4

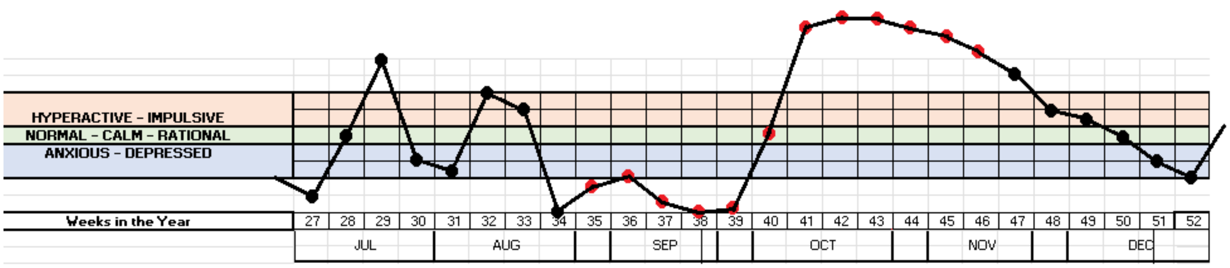


SCORE (mid week value)	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
SINE = BLUE LIGHT	-4	4	4	-4	-4	4	4	-4	-4	4	4	-2	2	-2	2	-2	2	-2	2	-2	2	0	0	0	0	0
BIPOLAR ANGLE	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4	4	2	1	0	-2	-4
TOTAL	-6	0	8	-2	-3	4	2	-8	0	6	5	-2	0	-6	6	0	3	-2	0	-6	6	2	1	0	-2	-4

Figure 7

Final aggregate temperament map of weekly scores of the combined two dopamine cycles with the modification for the spring and fall pollen season serotonin cycles and final weekly scores that could be displayed on a smartphone app.





SCORE (mid week value)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
SINE = BLUE LIGHT	0	0	0	0	2	-2	2	-2	2	-2	2	-2	2	-2	2	-2	2	-4	-4	4	4	-4	-4	4	4	-4
BIPOLAR ANGLE	2	0	-2	-5	5	4	2	0	-2	-5	5	4	2	0	-2	-5	5	4	2	0	-2	-5	5	4	0	-2
HISTAMINE-SEROTONIN CYCLE	0	0	0	0	0	0	0	-2	-6	-7	-10	10	9	12	6	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	0	-2	-5	7	2	4	-4	-6	-14	-3	12	13	10	6	-7	7	0	-2	4	2	-9	1	8	4	-6

SCORE (mid week value)	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
SINE = BLUE LIGHT	-4	4	4	-4	-4	4	4	-4	-4	4	4	-2	2	-2	2	-2	2	-2	2	-2	2	0	0	0	0	0
BIPOLAR ANGLE	-5	5	4	2	0	-2	-5	5	4	2	0	-2	-5	5	4	2	0	-2	-5	5	4	2	0	-2	-5	5
HISTAMINE-SEROTONIN CYCLE	0	0	0	0	0	0	0	0	-5	-10	-10	-4	-4	-4	5	13	10	15	13	6	0	0	0	0	0	0
TOTAL	-9	9	8	-2	-4	2	-1	1	-5	-4	-6	-8	-7	0	11	13	12	11	10	9	6	2	0	-2	-5	5

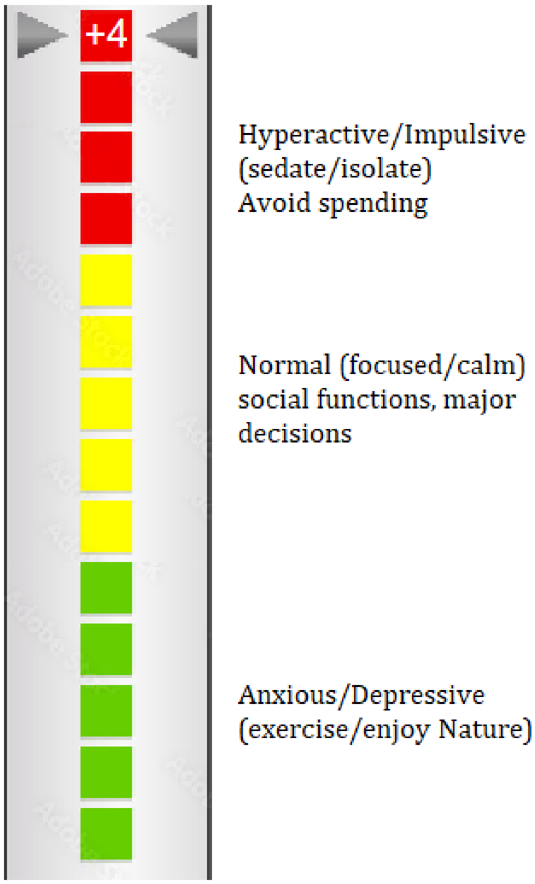
Figure 8

An aircraft cockpit instrument that monitors real-time altitude and orientation as an example of a "state" monitoring tool. An application that is absent for the human mind and body.

Source: https://allavionics.com/product/uavionix-av-30-c-primary-flight-display-certified/?gclid=Cj0KCQiAgP6PBhDmARIsAPWMq6mYOXR2xaEPKh_fBgayUXjlJJD1DIXeyipNQ7nudgaN38LTI1gdBOsaAkmwEALw_wcB

Figure 9

Example of a possible smartphone application where a standard meter scale is used to notify the user by color and the number on their scale of temperament per any given week or day of the year to allow them to adjust accordingly knowing how their physiology may have their state of mind biased.



Source: https://www.123rf.com/photo_140341271_stock-vector-bar-of-meter-with-progress-level-from-red-to-green-vector-illustration.html

Figure 10

Example possible smartphone application or patent (color-coded circular display icon in the upper-left corner of an electronic watch where +4 during week 7 of a year indicates a probable baseline high-dopamine hyperactive state).

Source: https://www.runnersworld.com/gear/a37975588/apple-watch-series-7-review/