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OPINION

Serotonin and Depression. A Sceptical Eye's View

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ABSTRACT

Depression is one of the most common and widespread medical issues and major depression is also one of the most disabling of all medical conditions. Although enormous efforts have been invested in research, there is no evidence that an abnormality in serotonin levels or other monoamines causes depression or that certain people are genetically predisposed to produce too little serotonin and therefore to experience depression. As Allen Frances, the Chair of the Diagnostic and Statistical Manual IV (DSM-IV) Task Force said: "Billions of research dollars have failed to produce convincing evidence that any mental disorder is a discrete disease entity with a unitary cause. Dozens of different candidate genes have been "found," but in follow-up studies, each turned out to be fool's gold." Now we just have to figure out WHAT we can trust. Proper education for the students and teachers is one approach.

Introduction

Concern for mental health begins with the study of the elementary biochemical basis of monoamine type of neurotransmitters. The assertion that there is no evidence that an abnormality in serotonin levels or other monoamines causes depression [1] and Allen Frances' quote [2] is crystalized as unequivocal truth and have been confirmed in the landmark article [3] about the involvement of serotonin, serotonin receptors, serotonin transporters or tryptophan depletion in the aetiology of depression. The first few sentences and the last ones in the article reveal that, the serotonin hypothesis of depression is still influential. We aimed to synthesise and evaluate evidence on whether depression is associated with lowered serotonin concentration or activity in a systematic umbrella review of the principal relevant areas of research. This review suggests that the considerable research effort based on the serotonin hypothesis has not produced convincing evidence of a biochemical basis for depression. This is consistent with research on many other biological markers. We suggest it is time to acknowledge that the serotonin theory of depression is not empirically substantiated."

Monoaminergic dysfunction in the central nervous system, serotonin in the case of depression, was born as an idea in 1960' with the observations obtained with alkaloid reserpine [4]. This compound is an inhibitor of the vesicular monoamine transporter located in presynaptic neurons. Attention was drawn to the observation that reserpine causes depression, in otherwise statistically questionable experiments [5] and the idea was born that lowered serotonin levels are the cause of depression. Later,

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when fluoxetine (Prozac) was approved for use, the depression-mongering and intense marketing lead to a dramatic rise in the use of selective serotonin reuptake inhibitors, the type of antidepressants that "correct" – elevate too low level of serotonin in synapses. The physicians justify their use by this argument: hypercholesterolemic patients have elevated level of cholesterol in their blood so we apply the statins to correct this level or diabetic patients have elevated glucose level so we have to use insulin to lower it. In the case of depression, the depressive patients have reduced level of serotonin in the synapses so we have to use SSRIs to correct it. This is an obvious case of so called wrong analogy logical fallacy. There is no evidence to support the idea that psychiatric drugs act in this disease centred manner. The disease centred model of treatments resulted in some very effective drugs such as hormones thyroxin or insulin or antibacterials like penicillin or sulphonamides. Psychiatry was following this general trend within medicine hoping for development of more efficient treatment and bringing psychiatry in line with modern medical science and abandoning psychoanalysis. However, there is a little evidence that psychiatric drugs act in a specific, disease centred model. The proof of this in the case of antidepressants is their clinically meaningless efficiency [6]. Similarly, recent meta-analysis finds no support for dopamine hypothesis of schizophrenia. And last but not least, the general statement about psychiatric treatments was written in a recent article, published in JAMA Psychiatry where researchers write that there is no evidence that psychiatric interventions lead to "successful" outcomes [7]. In my own belief, the right place to become aware of this serotonin and depression as well as other delusions is at the very beginning of studying biochemistry at the Faculty of Medicine and the Faculty of Pharmacy. When I asked a scientist, working on brain chemistry at the Institute of Biochemistry at the Faculty of Medicine, University of Ljubljana, what depression is, he/she fired the answer in a millisecond: "Deficiency of serotonin in synapses...of course!" and was surprised that I did not know that. As we can read in the article from Molecular Psychiatry and many other articles [9-11] this answer is completely wrong, therefore we have to inform such scientists and biochemistry teachers about the misconception about the mechanism of depression and thus lay a sound foundation for students of pharmacy and medicine for understanding many psychological problems and not to "biologyse" them. The so-called "chemical imbalance theory" is the most supported biogenetic explanation of depression. In one study, nearly all of the undergraduate students taking a psychology course (92%) were familiar with this theory and 85% that this explanation was endorsed as a cause of depression and 62% endorsed genetic belief. Of patients taking antidepressants, 85% believe in a chemical imbalance story and 77% that genes played a role [8]. Textbooks of biochemistry, physiology and similar fields bear part of the responsibility for this. Let us summarize the claims about the connection between serotonin and depression according to textbooks of biochemistry and some other textbooks.

John H. Krystal [9], editor-in-chief of the journal Biological Psychiatry from 2006 to present, wrote in the textbook Charny & Nestler's Neurobiology of Mental Illness: "Sixty years after the discovery of antidepressant medications, it is not entirely clear how they work"[10]. But a few tens of pages before this statement we can read in the same textbook: "A deficiency in the monoamine neurotransmitter system (serotonin, dopamine, and norepinephrine) has been observed in depressed individuals, and is one theory that may help to explain the pathophysiology of depression. Indeed, a large class of antidepressant medication, Selective Serotonergic Reuptake Inhibitors (SSRI), is designed to treat depression through the monoamine system by increasing the amount of serotonin available in the synaptic cleft through several mechanisms" [11].

In Marks' Basic Medical Biochemistry: A Clinical Approach [12] we can read: "When serotonin levels are high, satiety results; when serotonin levels are low, increased appetite, or depression, or both, can occur. Because levels of serotonin have been linked to mood, many antidepressant drugs were developed that affect serotonin levels. The first of these is the MAO inhibitors, the second class is the tricyclics, and the third class is known as Selective Serotonin Reuptake Inhibitors (SSRIs). The SSRIs block reuptake of serotonin from the synapse, leading to an elevated response to serotonin. Redux not only acted as an SSRI but also increased the secretion of serotonin, leading to elevated levels of this compound in the synapse. None of the other drugs that affect serotonin levels has this effect. Evan A, after stopping Redux, was placed on Prozac, an antidepressant that acts as an SSRI but does not lead to increased synthesis or secretion of serotonin, as did the dexfenfluramine in Redux. Thus, the mechanism of action of these two drugs is different, even if the result (elevated levels of serotonin) is the same."

In Biology, A Global Approach [13], it is written that "Biogenic amines have a central role in several nervous system disorders and treatments. The degenerative illness Parkinson's disease is associated with a lack of dopamine in the brain. In addition, depression is often treated with drugs that increase the brain concentrations of biogenic amines. Prozac, for instance, enhances the effect of serotonin by inhibiting its reuptake after it is released by presynaptic neurons."

In Ganong's Review of medical physiology, 26th ed., we can read [14]: "In cases of typical depression, drugs such as fluoxetine (Prozac), which are Selective Serotonin Reuptake Inhibitors (SSRIs), are effective as antidepressants. SSRIs are also used to treat anxiety disorders. In atypical depression, SSRIs are often ineffective. Instead, Monoamine Oxidase Inhibitors (MAOIs) such as phenelzine and selegiline are effective as antidepressants. Based on evidence that atypical depression may result from a decrease in both serotonin and dopamine, drugs acting more generally on monoamines have been developed. These drugs, called atypical antidepressants, include bupropion, which resembles amphetamine and increases both serotonin and dopamine levels in the brain."

Devlin's Biochemistry [15] 7th ed, (the same text is present in the 6th edition on p.957) says: "Serotonin is derived from tryptophan. Like dopamine, its action is terminated by reuptake by a specific transporter. Some types of depression are associated with low brain levels of serotonin; antidepressants such as Paxil (paroxetine hydrochloride), Prozac (fluoxetine hydrochloride), and Zoloft (sertraline hydrochloride) specifically inhibit serotonin reuptake."

Guyton and Hall's textbook of medical physiology [16], p770-1 says that "Much evidence has accumulated suggesting that mental depression psychosis, which occurs in more than 8 million people in the United States, might be caused by the diminished formation in the brain of norepinephrine or serotonin, or both. (New evidence has implicated still other neurotransmitters.). A principal reason for believing that depression might be caused by the diminished activity of norepinephrine- and serotonin-secreting neurons are that drugs that block the secretion of norepinephrine and serotonin, such as reserpine, frequently cause depression. Conversely, about 70 per cent of depressive patients can be treated effectively with drugs that increase the excitatory effect of norepinephrine and serotonin at the nerve endings-for instance monoamine oxidase inhibitors, which block the destruction of norepinephrine and serotonin once they are formed, and tricyclic antidepressants, such as imipramine and amitriptyline, which block the reuptake of norepinephrine and serotonin by nerve endings so that these transmitters remain active for longer periods after secretion."

In Fry's Essential Biochemistry for Medicine [17] we can read that "Depression is associated with reduced levels of the neurotransmitter serotonin. Selective Serotonin Reuptake Inhibitors (SSRIs) are widely used to treat depression. SSRIs increase the extracellular level of serotonin by inhibiting its reuptake into the presynaptic cell, thereby increasing its availability to the postsynaptic receptor. Fluoxetine hydrochloride (Prozac) is an antidepressant of the SSRI class."

Whereas Harper's illustrated biochemistry in the 26th ed. from 2003 does not mention depression, in the 31st ed. from 2018 [18] we can read that "The psychic stimulation that follows the administration of iproniazid results from its ability to prolong the action of serotonin by inhibiting monoamine oxidase. The same text can be also found in the latest, 32nd ed. from 2023 [19].

In the 8th edition of Stryer's Biochemistry on page 238 it is written: » Parkinson's disease is associated with low levels of dopamine, and depression is associated with low levels of serotonin « [20].

In R. Carter's "The human brain book" [21] on p.197 we can read: "several genes in the genome may code for the protein molecules that make serotonin, one of the neurotransmitters involved in mood. Each variant of this gene makes a slightly different protein molecule, which may carry out its job more, or maybe less, efficiently. Thus, gene variants may result in one person having more serotonin and another person having less serotonin. Less serotonin may mean a predisposition to depression or a tendency to overeat. This is also true of other neurotransmitters, such as dopamine" and on page 239: "Various biological abnormalities have been found in the brains of depressed people, such as decreased levels of the neurotransmitter serotonin, raised levels of the enzyme monoamine oxidase, loss of cells from the hippocampus (an area of the brain involved in mood and memory), and abnormal patterns of neural

activity in the amygdala and parts of the prefrontal cortex. However, the mechanisms by which such biological abnormalities may lead to depression are not known."

"Serotonin is a neurotransmitter that suppresses pain and helps control mood. Deficiency of serotonin is associated with depression." is written in Pelley's book Rapid review biochemistry [22], "serotonin is a stimulator (excitation) of brain activity, hence its deficiency causes depression. Serotonin level is decreased in psychosis patient" (p.356) says Satyanarayana in his book Biochemistry [23]. In the Indian Textbook of Biochemistry for Medical Students, we can read: »Selective Serotonin Reuptake Inhibitors (SSRI) are widely used in the treatment of a psychiatric disorder.", and shortly after that: "Serotonin level is found to be low in patients with depressive psychosis"[24]. But in the next edition, the first claim, the wide use of SSRIs, is omitted [25]. In Salway's textbook is written [26] that "Serotonin (5-hydroxytryptamine) is produced from tryptophan by the indoleamine pathway. Serotonin is important for a feeling of well-being, and a deficiency of brain serotonin is associated with depression. The Selective Serotonin Reuptake Inhibitors (SSRIs) are a successful class of antidepressive drugs that prolong the presence of serotonin in the synaptic cleft, thereby stimulating synaptic transmission in neurones that produce a sense of euphoria."

Even in, to my opinion, the most comprehensive and sophisticated textbook of biochemistry ever written, Metzler's Biochemistry [27], we can find the following statements: "The fact that L-tryptophan has some antidepressant activity, but L-dopa does not, was one clue that a low concentration of serotonin (5-hydroxytryptamine) might be responsible for depression. Strong support for the biogenic amine theory of depression is provided by the powerful antidepressant effect of inhibitors of monoamine oxidase." (p.1809), or "In 1986, the less toxic serotonin reuptake inhibitor fluoxetine (Prozac; Fig. 30-28) was introduced and is now used by many millions of people. Nevertheless, its mode of action is not entirely clear. Interestingly, depression sometimes responds to a placebo just as well as to an antidepressant drug. Antidepressants seem to stimulate the growth of new cells as does exercise, which also has an antidepressant effect. Dietary treatment can also help. Among older people, depression may be caused by deficiency of vitamin B12 and can be treated by injection of the vitamin." (p.1810). A fair enough description, although in the first years of a new millennium, when this book was written (2003), the water with dissolved serotonin and depression was already muddy [28].

In Charney & Nestler's Neurobiology of Mental Illness [29] we can also read: "The goal of the DSM is clinical reliability rather than biological validity." Indeed, in the Diagnostical Statistical Manual (DSM) there are no mentions of a "chemical imbalance" of serotonin or norepinephrine in depressive disorders. Neither in Lehninger's Principles of Biochemistry, 8th ed. the connection between serotonin and depression is not alluded to. But in the 6th and 7th editions on page 20, we can read: "The antidepressant medication citalopram (trade name Celexa), a selective serotonin reuptake inhibitor, is a racemic mixture of these two stereoisomers, but only (S)-citalopram has the therapeutic effect. A stereo chemically pure preparation of (S)-citalopram (escitalopram oxalate) is sold under the trade name Lexapro. As you might predict, the effective dose of Lexapro is one-half the effective dose of Celexa."

In Blanco's Medical biochemistry on p.638, we can read that "Alteration of serotonin, dopamine, and norepinephrine levels result in serious pathological conditions. Depressive states improve with the administration of drugs that increase transmission at serotoninergic synapses. The deficient production of dopamine is involved in the development of Parkinson's disease. Alteration of dopaminergic transmission is also involved in schizophrenia"[30].

In Textbook of Medical Biochemistry (3rd ed.) by Dinesh Puri, the Principles of Medical Biochemistry: With student consult, Online Access, 3rd ed. by Meisenberg and Simmons or in Medical Biochemistry: Human Metabolism in Health and Disease by Rosenthal and Glew the connection between serotonin and depression is not mentioned.

Voet & Voet's Biochemistry in 5th ed. says that: "Deficiency in dopamine production is associated with Parkinson's disease, a degenerative condition causing "shaking palsy; serotonin causes smooth muscle contraction" Its role in depression is not mentioned.

In Essential biochemistry by Pratt and Cornelly, p531, we encounter this statement: "**Low levels of serotonin in the brain have been linked to conditions such as depression, aggression, and hyperactivity**."

On page 181 of Biomedical Chemistry: Current Trends and Development, N. Vale we read: "Trp is processed to form serotonin, a neurotransmitter that is linked to depression at low levels" [31].

And more as a frivolous insert at the end of this file of authors we can add a Slovenian writer Branko Gradišnik, an artist and translator without any biomedical education. He wrote in one of his latest books [32], which is about the unnecessary consumption of health services, this sentence: "Tianeptine, a Selective Serotonin Reuptake Enhancer (SSRE), has the same effect on depression as Selective Serotonin Reuptake Inhibitors, a well-known class of antidepressants, so-called SSRI antidepressants." Some antidepressants increase serotonin levels, some decrease them, and some do not affect serotonin levels at all. Nevertheless, they all show the same therapeutic benefit.

Conclusion

Let us find sense in the above excerpts from textbooks. What does it mean "70 per cent of depressive patients can be treated effectively with drugs that increase the excitatory effect of norepinephrine and serotonin at the nerve endings", as written in In Guyton and Hall's textbook of medical physiology? How is it possible that SSRE and SSRI types of antidepressants have the same effect on depression? Randomized controlled trials of SSRIs are designed in the way that a positive, although only statistical, and not a clinically significant difference between placebo and drug is guaranteed. And even these fraudulent, published positive results, if combined with unpublished results that were hidden by drug companies, make small differences disappear [33]. Another reason is that this small statistical difference between antidepressants and placebo may be an enhanced placebo effect because most patients and doctors in clinical trials successfully break blind. So this assessment, 70 %, has a very questionable value. Nevertheless, most general practitioners or psychiatrists justify the use of SSRIs (or SSREs or SNRIs) by this trivial explanation: "If your cholesterol level is high, then you should take statins. If subsequently, it falls, then the statin is working, and you should stay on it." Also, a similar story holds for blood sugar: "if your glucose is high, then you should take metformin or insulin for the rest of your life." This weapon is used to justify the prescription of antidepressants to patients: "If you happen to have a serotonin imbalance in your brain, you should take a selective serotonin reuptake inhibitor to correct that," or, "your serotonin level is low (how do they know this?) so you have to use SSRIs to elevate it." This is, as we see, a completely wrong explanation as a classical example of the wrong analogy logical fallacy [34]. On the other side, The British Psychological Society has also stated: "no major genes of significant effect have been identified for any functional diagnosis". Despite these facts, the development and promotion of SSRIs in the 1990s significantly increased the diagnosis and treatment of depression [35]. It is difficult to understand why professors of biochemistry, pharmacology or psychiatry teach this never proven mechanism, although many of them are well aware that this postulate is an erroneous myth. Are they concerned about their careers? Teaching biochemistry is a place where students encounter these false claims for the first time. Let us do something to correct this mistake.

As the United Nations Special Rapporteur on the right to health, Dainius Pūras, said". "Other major obstacles included the dominance of the biomedical model, with its overdependence on medication, and the "biased" use of evidence, which was contaminating knowledge about mental health. There is now unequivocal evidence of the failures of a system that relies too heavily on the biomedical model of mental health services, including the front-line and excessive use of psychotropic medicines, and yet these models persist" [36]. Finally, Wayne Goodman, Chair of the FDA Psychopharmacological Advisory Committee, admitted that the serotonergic theory of depression is a "useful metaphor" - and one that he never uses within his psychiatric practice [37]. "Contemporary neuroscience research has failed to confirm any serotonergic lesion in any mental disorder, and has provided significant counterevidence to the explanation of a simple neurotransmitter deficiency" [38].

Correcting the approach in teaching biochemistry in this field is the first step towards blowing away the fog around serotonin and depression.

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REFERENCES

1. Dubovsky SL, DR Dubovsky AN. Mood disorders. In R.E. Hales & S.C. Yudovsky (Eds.) Textbook of clinical psychiatry. Washington, DC: American Psychiatric Association. 2001
2. 12 Essential Facts About Psychiatry.
3. Moncrieff J, Cooper RE, Stockmann T, et al. The serotonin theory of depression: a systematic umbrella review of the evidence. Mol Psychiatry. 2022. doi: 10.1038/s41380-022-01661-0.
4. Hull LD, Horita A. Reserpine reversal response by iproniazid: a dose dependent phenomenon. Nature. 1964;202:604-5. doi: 10.1038/202604a0. PMID: 14195072.
5. Mendels J, Frazer A. Brain biogenic amine depletion and mood. Arch Gen Psychiatry. 1974;30(4):447-51. doi: 10.1001/archpsyc.1974.01760100019004. PMID: 4273761.
6. Moncrieff J. The creation of the concept of an antidepressant: an historical analysis. Soc Sci Med. 2008 Jun;66(11):2346-55. doi: 10.1016/j.socscimed.2008.01.047. Epub 2008 Mar 5. PMID: 18321627.
7. Freedland KE, Zorumski CF. Success Rates in Psychiatry. **JAMA Psychiatry.** Published online March 22, 2023. doi:10.1001/jamapsychiatry.2023.0056
8. The Opinions of Italian Psychology Students About People Diagnosed With Depression And Schizophrenia: A Comparative Study. 2017.
9. Krystal JH. Krystal reports having received research funding from Veteran Affairs National Center for PTSD and is a consultant for AbbVie, Inc., Amgen, Astellas Pharma Global Development, Inc., AstraZeneca Pharmaceuticals, Biomedisyn Corporation, Bristol-Myers Squibb, Eli Lilly and Company etc.
10. Charney DS, Buxbaum JD, Sklar P, Nestler EJ. Charney & Nestler's Neurobiology of Mental Ilness, 5th edition, Oxford, 2018, 387.
11. Charney DS, Buxbaum JD, Sklar P, Nestler EJ. Charney & Nestler's Neurobiology of Mental Ilness, 5th edition, Oxford, 2018, 321.
12. **Lieberman MA, Peet A.** Mark's Basic Medical Biochemistry, 5th edition, Pearson, 963-5.
13. Campbell NA, Urry LA, Cain ML, Wasserman SA, Minorsky PV, Reece JB. Biology, A global approach, 12th edition, 2020, 1139.
14. Ganongs review of medical physiology.
15. Devlin TM. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Wiley, 950.
16. Hall JE, Hall ME. Guyton and Hall Textbook of Medical Physiology, 14th edition, **Elsevier Health,** 770-1.
17. Fry M, Essential Biochemistry for Medicine, 2010, Wiley-Blackwell, 241.
18. Zoya. Harpers Illustrated Biochemistry 31st edition pdf free download. March 29, 2022.
19. Harper's Illustrated Biochemistry, Thirty-Second Edition 32nd Edition, Kindle Edition.
20. JM Berg, JL Tymoczko, Gatto GJ Jr., Stryer L. Biochemistry, 8th edition, W. H. Freeman, 2015, 238.
21. Carter R. The Human Brain Book: An Illustrated Guide to its Structure, Function, and Disorders, DK, New edition, 2019, 197.
22. Pelley JW, Goljan F. Rapid review biochemistry, 3rd edition, Mosby Elsevier, 2010, 112.
23. Satyanarayana, Biochemistry, 5th edition, Elsevier, 2017, 356
24. Vasudevan DM, Sreekumari S, Vaidyanathan K. Textbook of Biochemistry for Medical Students, 6th edition, Jaypee, 2011, 212.
25. Vasudevan DM, Sreekumari S, Vaidyanathan K. Textbook of Biochemistry for Medical Students, 7th edition, Jaypee, 2016, 295.
26. Salway JG. Medical biochemistry at a glance, 3rd edition, Elsevier, 2012, 143.
27. Metzler DE. Biochemistry, Academic Press, 2003, 1809, vol 2.
28. Moncrieff J. The antidepressant debate. BJ Psych. 2002; 180 (3): 193-194. doi:10.1192/bjp.180.3.193
29. Charney DS, Buxbaum JD, Sklar P, Nestler EJ. Charney & Nestler's Neurobiology of Mental Ilness, 5th edition, Oxford, 2018, 245.
30. Blanco A, Blanco G. Medical Biochemistry, 1st edition, Elsevier, 2017, 638.
31. Vale N. Biomedical Chemistry: Current Trends and Developments, De Gruyter Open Ltd, 2016, 181.
32. Branko Gradišnik. Iskanje izgubljenega zdravja. Umco, 2017, 344.
33. Kirsch I. Antidepressants and the Placebo Effect. Z Psychol. 2014;222(3):128-134. doi: 10.1027/2151-2604/a000176. PMID: 25279271; PMCID: PMC4172306.
34. Lynch T. Depression delusion. Mental Health Publishing. 2015, 229.
35. Marcus SC, Olfson M. National Trends in the Treatment for Depression From 1998 to 2007. Arch Gen Psychiatry. 2010;67(12): 1265–1273. doi:10.1001/archgenpsychiatry.2010.151
36. World needs "revolution" in mental health care – UN rights expert
37. Lacasse J, Leo J. Questionable Advertising of Psychotropic Medications and Disease Mongering. PLoS medicine. 2006;3:e321. https://doi.org/10.1371/journal.pmed.0030321
38. Lacasse J R, Leo J. Serotonin and depression: A disconnect between the advertisements and the scientific literature. PLoS Medicine. 2005;2(12):1211-16.

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