Review

Role of education after the COVID-19 pandemic fear: a multidisciplinary and scientific perspective

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Abstract

In response to the outbreak of the novel Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), pathogen of the new coronavirus disease (COVID-19), several sectors and social activities have been affected, including education. At first, it is explained that educators and students can feel fragile during and after the SARS-CoV-2 outbreak. Subsequently, it is discussed that their relationship ought to be carefully established given the triggering of psychological and neuropsychiatric effects arising from neural coding and plasticity processes, which result in the formation of positive and negative memories in the short to long term. Finally, it is pointed out that the SARS-CoV-2 pandemic generates a need for adequacy and adaptation for the significant attention to studdents during the re-starting of studies, given that possible disorders of sensory modulation and involvement of limbic brain areas triggered in situations of risk of death, potential or real threat, can happen. It is assumed that at times of the SARS-CoV-2 pandemic, in addition to preserving life, one of the challenges is the behavioural (re)organisation, which includes habits from the educational context that need to contemplate a scientific perspective, seeking to transform the consequences of the pandemic fear on opportunities to reinforcement of familiar links. In the context of modern rationality, the SARS-CoV-2 pandemic is also a period to think about the relationship between scientific knowledge and common sense. With this logic, neurosciences can develop a new format for the teaching-learning process, so that educators and students experiencing the pandemic threatening do not manifest psychological distress and secondary consequences. Therefore, education can be considered a central space in decision-making in the face of SARS-CoV-2 pandemic. In this sense, the urgency of a multidisciplinary strategies development is highlighted,

connecting the synergy between neurosciences and education after the COVID-19 pandemic.

Keywords: COVID-19, pandemic fear, anxiety, neurociences, education.

1. Introduction

At the end of 2019, precisely in mid December in Wuhan, China, cases of pneumonia with unknown cause began to appear. After performing evaluations of patients with the disease, a new type 2 of Coronavirus (SARS-CoV-2), RNA enveloped virus, was discovered that cause respiratory, hepatic, enteric and neurological new coronavirus disease (COVID-19) (1).

After contamination in China, the virus has spread rapidly around the world to the point of being considered a pandemic by the World Health Organisation (WHO) (2). The SARS-CoV-2 has a viral evolution with high pathogenicity and high transmissibility (1). Outbreaks like this promote possibilities of transformations within several places and social activities (3).

2. The pandemic and its consequences on education

The unusual situation caused by the SARS-CoV-2 pandemic affects and exposes educators and learners to weaknesses and potentialities to raise the need for criteria that provides support to face up the new conditions. The cognitive development criterion is the result of different stimuli and synaptic activation into the hipoccampus and cerebral cortex, crucial aspects for teaching-learning. However, research indicates that several types of coronavirus can invade the central nervous system (CNS) (4).

In other terms, we might consider the possible occurrence of viral transmission in the encephalon, reached after intranasally viral infection, through synaptic contacts in the sensorial systemand neurotropism (5). As taken along this way, coronavirus can attack the teaching-learning process by weakening educators and learners who can experience a range of negative emotions, affecting mood and bahavioural skills when dealing with the information about the COVID-19.

3 Fear and anxiety as risk factors for triggering psychiatric disorders during the COVID 19 pandemic

The need for social isolation caused by the COVID-19 pandemic, combined with global uncertainty related to SARS-CoV-2, has generated a lot of tension and suffering. Although the world has already experienced other similar events, nothing was reported until now in proportions and speed of spread like the current pandemic (6).

In the face of so many changes and uncertainties, natural reactions arise, such as unconditioned and conditioned fear and chronic anxiety itself, which, to a certain extent, provide care and prevention, but which can reach unbearable or even dysfunctional or pathological levels. In this scenario, prophylactic social isolation causes several risks to mental health (7). Isolation has been a strategy adopted aiming to mitigate the spread of the virus and was readly adopted at other critical times. However, it is also known that the longer we are isolated, the greater the risks of suffering from psychiatric illnesses (8).

It is still necessary to consider the fact that during pandemics, attention is focused on the pathogen and its inherent biological risk, measures to be taken for prevention, containment action and medical protocols for the treatmentof the disease.

As a result, psychological and psychiatric implications secondary to the pandemic phenomenon, at the individual and collective levels, tend to be underestimated and neglected (9, 10).

Reynolds et al. (11) reported that during social isolation a constellation of psychopathological symptoms may appear, such as depressed mood, irritability, anxiety, fear, anger, insomnia, among others, remaining long-term consequences for mental health. Hawryluck et al. (12) reported that even three years after a period of isolation, there was still a greater risk for alcohol abuse, symptoms of post-traumatic stress disorder and depression.

The most significant areas of activation during social anxiet disorder are the following: bilateral amygdaloid complex, the left medial temporal lobe encompassing the entorhinal cortex, the left medial aspect of the inferior temporal lobe encompassing perirhinal cortex and the parahippocampal gyrus, the right anterior cingulate cortex in human beings, according to Hattingh et al. (13). The amygdalid complex, the entorhinal cortex, the cingulum gyrus and the hippocampus and parahippocampal gyrus are connected to the limbic system the main encephalic system related to the organisation of emotions in human beings and in other mammals. Additionally, the right brain hemisphere specific thinning was found in the frontal, temporal, parietal and insular cortices of individuals with social anxiety disorder (14).

Shigemura et al. (15) reported that patients infected with COVID-19 (or suspected of being infected) may experience intense emotional and behavioural reactions, such as fear, boredom, loneliness, anxiety, insomnia or anger, symptomns already reported in conditions of epidemics occurring in the past (BROOKS et al., 2020).

In a pandemic, fear increases the levels of anxiety and stress in healthy individuals and intensifies the symptoms of those with pre-existing psychiatric disorders (15). However, little is known about individuals affected by their reactions based on fear of infectious disease. In China, the initial focus of the current pandemic, high levels of depression, post-traumatic stress, anxiety and insomnia have occurred among health professionals (16, 17) and their patients infected by COVID-19 (18), but the extent to which these psychological conditions are attributable to coronavirus anxiety has not been determined.

Corroborating these concerns, in a recent study using 775 adults citizens living in the United States of America, individuals functionally impaired by the fear and anxiety of the coronavirus exhibited greater hopelessness, suicidal ideation, spiritual crisis and problems with alcohol/drug abuse than those who were anxious, but they did not have dysfunctional anxiety because of COVID-19 (19).

In previous research on the hurricane and flood, as well as other infectious disease epidemics, adverse psychological reactions covering anxiety, acute stress, addictive behaviours and symptoms of post-traumatic stress disorder, along with increased suicide and depression stood out in the population during and after these threatening events (20). Thus, it is believed that they will certainly occur in the current COVID-19 pandemic.

Another important point, based on the observation of previous events, is that during pandemics, the number of people whose mental health is affected tends to be greater than the number of people affected by the infection itself. Previous tragedies have shown that the implications for mental health can last longer and have a higher prevalence than the epidemic or pandemic itself and that the psychosocial and economic impacts (15).

It is believed that fear can be the centre of many of these conditions because it is one of the most basic and primordial human emotions. Fear is a primitive emotion that is considered conservative in the animal kingdom (21). In the pandemic, there are still feelings of helplessness and loss of a fundamental sense of security, financial stability and the ability to predict a better future. The fear of infection, of being contaminated in the environment or contact with people evokes more and more distrust, avoidance and withdrawal, thus reducing our social interactions and restricting opportunities for contact and social support, which are very important for adaptive behaviour (22).

Fear is composed of several variables and determinants and the study of neurobiological structures involved in its genesis is complex. One of the particularities associated with stress, fear and anxiety is the generalisation phenomenon that can have an adaptive value. However, overgeneralisation is inadequate and is one of the main characteristics of mental disease such as post-traumatic stress disorder (23). In this understanding, the maladaptive generalisation of fear occurs when an abnormal stimulus-response gradient emerges to produce defensive behaviours in environments or clues that are not explicitly associated with threat or danger (24).

Concerning the possibility of exposure to triggering stimuli, it is estimated that up to 50 to 60% of the North American population may be exposed to at least one traumatic event in life (25) and although most individuals recover from the traumatic experience, about 10 to 30% develop post-traumatic stress disorder and, although pharmacological and psychotherapeutic treatment is often effective, 20 to 30% of patients with this condition do not respond to conventional therapies (26).

So, at the current juncture, if a large number of people tend to experience clinically significant fear and anxiety during an outbreak of infectious disease (27) (TAYLOR, 2019) and if there is a massive exposure of the whole society to potentially

traumatic events, as in the case of COVID-19 pandemic, there is a risk that many people will develop anxiety disorders such as post-traumatic stress disorder. Thus, it is crucial that health professionals understand the psychological risks of those with this specific condition (28).

But if, on the one hand, as described by Dong and Bouey (29), fear and anxiety are common psychological responses during disasters and other similar situations, the entire population is more vulnerable to the development of mental disease in these critical events, especially the anxiety disorders. These mental disorders are classified, according to the 5th edition of the Diagnostic and Statistical Manual of mental disorders (DSM-5), into a generalised anxiety disorder, panic disorder, agoraphobia, separation anxiety disorder, social anxiety disorder, specific phobias and selective mutism (30).

Corroborating concerns about the onset of these mental disorders, Batelaan et al. (31) noted that there is evidence that anxiety disorders increase the incidence of cardiovascular diseases by 52% and that the severity of anxiety symptoms would be directly associated with functional impairment (32). Supporting these findings, it is understood that, in an attempt to preserve its homeostasis, the body reacts with adaptive responses, mediated by neuroendocrine and neuronal defensive activity, involving the autonomic nervous system and activation of the Hypothalamus-Pituitary-Adrenal axis (HHA) and the release of cortisol. The functional abnormalities of this axis alter the response to stressful events, contributing to the developmentof anxiety disorders (33).

In acute anxiety, the activation of the HHA axis is adaptive. On the contrary, in chronic anxiety, this mechanism fails, the HHA axis remains activated and impairs coping mechanisms, in addition to inducing low tolerance to chronic stress (34). Chronic stress, on the other hand, has consequences for cognitive and emotional processing and is associated with changes in brain plasticity, can affect the immune

system, increase the risk for developmental diseases, impairment of negative feedback from the HHA axis, decrease in neurotrophic factors, among others (34). Thus, the literature already has robust evidence of a role played by stress in the development of psychiatric disorders in both laboratory animal (35) and in human experimental models (36), in addition to contributing to the appearance or worsening of clinical conditions.

In extreme cases, these mental health problems can lead to suicidal behaviour. It is well established that about 90% of global suicides are due to mental disorders such as depression (37). Based on these findings and experience in previous pandemics, such as Severe Acute Respiratory Syndrome Coronavirus-1 (SARS-CoV-1) in 2003 when the suicide rate among the elderly increased in Hong Kong during and after the pandemic (38, 39), the present issue is relevant and must be considered with due seriousness.

Although until now the effects of COVID-19 on mental health have not been studied systematically, it is expected to produce significant effects due to public reactions already observed (40). Observing this reaction and in previous experiences, the National Health Commission of China has taken important steps and issued a notification stipulating guidelines for emergency interventions in cases of psychosocial disasters, in order to reduce the psychosocial impacts of the COVID-19 outbreak, with teams composed of psychiatrists, mental health professionals and psychological support hotlines (41). According to these concerns, the Department of Mental Health and Psychoactive Substances of the World Health Organisation (2) has published a document with recommendations aimed at mental health and psychosocial well-being by placing psychiatrists and psychologists to assist other health professionals, patients and the general public to understand the possible effect of COVID-19 and help their patients, families and the general public.

Supporting the same line of reasoning of the need to implement efforts to care for the mental health of the population in the pandemic, Gao et al., (2020) presented the result of a survey conducted in China, where they concluded that there is a high prevalence of health problems mental disorders, such as depression and anxiety, which were associated with massive exposure to social media during the COVID-19 outbreak. They highlighted the need to combat the spread of false news and the importance of circulating reliable information. Besides, they demonstrated that the implementation of measures such as mental health services through different channels is extremely important.

In conclusion, it is important to highlight the panorama of uncertainty, insecurity and isolation experienced by humanity as a catalyst for emotions and different feelings such as fear, anxiety and sadness. This whole scenario is favorable to the emergence of mental disorders, especially those with a spectrum of anxiety and mood, or even exacerbation of the condition in people who already have it. Against this background, there is a need for a more careful examination of authorities and health professionals in addition to the symptoms caused by COVID-19, especially concerning the mental health of the population

4 Psychological effects caused by the pandemic on educators and learners

In developing autonomy to conduct studies in times of COVID-19, one should consider that, in the encephalon, there are three levels of attention behaviour formation: the alert state; focus and concentration. The alert state is the initial condition for concentration in the teaching-learning process, as well as the adequacy and adaptation of educators and learners to the new physical and social context. Furthermore, the teaching-learning process must be permeated by motivation. Motivation is reflected in

attention and memory. With the maintenance of the alert state, one reaches the focus and consequently, the concentration (42, 43).

During and after the COVID-19 pandemic, the relationship between educators and learners must be carefully established before neural processes of coding and plasticity, which result in the formation of positive and negative memories, from short to long term (44).

The multidisciplinary study of cognitive and socio-affective processes in teaching-learning can benefit from the concept of function modularity, i.e. the notion that motivation, attention and memory comprise a set of skills and abilities mediated by different modules of the nervous system, which function independently, but cooperatively, for the development of autonomy and conduction of studies during and after the COVID-19 pandemic threat. In this follow-up, attention should also be paid to somatisation regarding the manifestation of physical symptoms resulted from psychological effects.

5. Pharmacological management on the Attention Deficit Hyperactivity Disorder (ADHD): relation in COVID-19 pandemic

Attention Deficit Hyperactivity Disorder (ADHD) is a neurobiological condition of genetic and environmental influences, which can set in early development (period inside the womb). It is characterised by a behaviour that goes to the extreme of inattention, restlessness and impulsiveness in a level that would not be expected for more advanced stages of the child development. That disorder can affect the person during adulthood (45). ADHD affects 5.3% of children and adolescents and 2.5% of adults, worldwide (46). The occurrence of that disorder increases the death rate, school difficulties and drug abuse, in addition to worsening job placement (45).

In the case of the COVID-19 outbreak, schools in China are closed and students are restricted to staying at home. Primary and secondary schools in China open official online educational sites to allocate students to continue education (47). Most parents of these children are required to have educational responsibility, in addition to dealing with all of children's emotional and behavioural problems 24 hours a day, 7 days a week.

The most effective current treatment for adults and children with ADHD is stimulating medications. Inattention and hyperactivity symptoms respond more to medications, but a person with the disorder often has several other associated problems that require interventions, such as psychoeducation, psychotherapy (48).

Zhang and colleagues (49) investigated conditions related to the mental health of children with ADHD during the COVID-19 outbreak. During the outbreak of COVID-19, ADHD symptoms in children were significantly worse compared to normal. These findings alerted the importance of focusing on special vulnerable groups during the outbreak. Attention is needed to identify an appropriate approach for children with ADHD in terms of disaster risk reduction activities.

6. School environment interventions based on complementary and integrative practices

The resumption of activities must be not only based on the fulfilment of the school curriculum but also support for psychological and social care. Psychological problems, when left untreated, can affect family/children's relationships, academic performance, and social functioning (50). Furthermore, childhood mental health problems often continue into adulthood and lead to decreased productivity, increased substance abuse, and substantial economic burden to the individual and society (51, 52).

Conventional medical treatments are based on pharmaceutical drugs and psychological therapy (53). However, the use of alternative and complementary therapies (manipulative/body techniques and practices based on attention, music therapy, etc.), can be an important adjunct treatment and or minimise the adverse effects themselves caused by pharmaceutical drugs (54, 55). There is evidence that therapies can help children reduce ADHD / ADD symptoms, autism, anxiety, depression, and stress (56, 57). Many studies have suggested mindfulness-based practices (e.g., yoga, tai chi, qigong, and meditation) may be a beneficial adjunct to the treatment of mental health problems, particularly mood and anxiety disorders improving quality of life (58). Mindfulness, the "intentional, accepting, and non-judgmental focus of one's attention on the emotions, thoughts, and sensations occurring in the present moment" (59).

Practices like yoga- and mindfulness-based procedures can positively impact the body in many ways, to increase alertness and positive feelings, and decrease negative feelings of aggressiveness, depression and anxiety (60, 61). A study showed the effect of mindfulness and yoga on quality of life for elementary school students and teachers indicate that both benefit on intervention. The students who received the intervention demonstrated significantly greater improvement in the psychosocial and emotional quality of life compared with their peers who received standard care (62).

There is evidence that one of the mechanisms through which yoga improves mood in major depressive disorder is by increasing the activity of the GABA system (63). Yoga practioners have increased functions on Superior Parietal Lobule and Supramarginal Gyrus of the cerebral cortex (64). Long-term Ashtanga Yoga practice decreased regional glucose metabolism in the medial temporal cortex, striatum, and brainstem (65). In brainstem is situated the main output of the encephalic aversion system, the periaqueductal grey matter (PAG), whose activation elicts unconditioned

fear and panic attack-like behaviour (66). Meditation and Yoga also was associated with a significantly lower right amygdala volume (67). Both PAG and amygdaloid complex neurons are also spontaneously activated in a threatening situation (68).

Another non-pharmacological intervention is the music therapy has always played crucial roles in the regulation of emotions and facilitating human well-being, resulting in elevated stress threshold and enhanced immunity, for improving quality of life and reducing anxiety (56, 69, 70). There is evidence that music procudes analgesia and depresses abnormal brain neural activity (71).

Thus, considering the real benefits of integrative and complementary therapies, the absence of side effects and the possibility of being applied in the school environment, it is interesting to show that its use can be an additional tool in improving post-pandemic education.

7. Discussion

7.1 Neurosciences and education in times of pandemic

The neurosciences applied to education aims to justify that the criterion of affective development influences the criterion of cognitive development, such as attention and memory. Therefore, there has been an important process of evidence on the importance of skill and capacity building mainly in the last decades, as well as the formulation and implementation of scientific actions to educational activity (72).

This perspective faced to the COVID-19 pandemic and after its passage supports educators and learners in issues regarding mental health. In brief logical reasoning, the engagement of brain areas involved with emotions, such as the limbic system, associated with the possibility of viral transmission between neurons, damages the

release process of important neurotransmitters such as glutamate and acetylcholine (excitatory), GABA and dopamine (inhibitors), in addition to serotonin (excitatory and inhibitory) and glial cells (which respond to environmental stimuli). Thus, it is assumed that SARS-CoV-2 may affect brain networks (or circuits) making them less effective, reflecting in afferent and efferent projections fundamental to the learning path (73).

In this sense, pedagogical practices can be conducted and supported by the application of scientific knowledge, as to be a source of further progress. In this regard, the opening of discussion spaces beyond content and discipline sets the triad between information support on COVID-19, socio-affective and cognitive processing. For the prescription of the integral development of educators and learners, the equilateral conservation of this triangle during and after the COVID-19 pandemic, goes against the multidisciplinary perspective, based on the fact that positive or negative stimuli weaken or enhance the associative neuroplasticity, which involves connectivity, regulation and neural modulation (74).

7.2. Role of Neuroeducation during the pandemic

The triad of informational, cognitive and socio-affective support during the COVID-19 pandemic awakens to the importance of scientific education (75). Information about the outbreak can generate problems, difficulties, disorders, and disruptions in the teaching-learning process that can gradually produce persistent changes in the behaviour of educators and learners. Thus, to be meaningful, the relationship between educators and learners must mutually produce appropriate responses adapted to sensory and emotional stimuli to maintain the appropriate alert state for the content transmitted during the pandemic (76).

7.3. Role of post-pandemic neuroeducation

Faced with a complex reality where confinement is the main prophylactic means to prevent the virus spreading (2, 77), educators and learners develop new behaviours of adaptation and appropriateness, where physiological transformations are produced in response to the outbreak. From fear to courage (and vice-versa), the process of resistance or "struggle" to confront the COVID-19, demands cognitive-affective attention to contain the exponential increase of fears and insecurities that generate psychic suffering.

In times of COVID-19, besides the preservation of life, one of the challenges is, therefore, the behavioural reorganisation, that is, habits that, in the educational context, must contemplate a scientific perspective, seeking to transform the consequences of the pandemic into opportunities. In this sense, neurosciences present neuroplasticity as the maximum law (43), a property that can prepare educators and students for confrontations and conflicts triggered during and after the COVID-19 pandemic. Moreover, through the adverse conditions that are being exposed, the development and prevalence of abilities and skills demand the need to build autonomy for the conduct of studies, based on the fact that teaching-learning is a dialectical process in which, for example, memory losses can be confused with attention losses, and vice-versa (78).

In the context of modern rationality, the COVID-19 pandemic is also a time to think about the relationship between scientific knowledge and common sense. Thus, neurosciences can develop a new path along the teaching-learning process, so that educators and learners who go through the pandemic do not manifest psychic suffering and secondary consequences, such as anxiety and depression (79).

A virus like SARS-CoV-2 cannot benefit from weaknesses, but be seen by potentialities, as a gateway to a new world, whose human evolution overcomes the

resilient way of feeling, remembering and making decisions. In other words, it is necessary to carry out an education that enables educators and learners to understand reality through science.

8. Conclusion

Because SARS-CoV-2 is not yet fully known, emotions such as fear and anxiety are usually conceived. Therefore, during this critical scenario within society, the validation of knowledge is fundamental for the creation of better methodologies, strategies and tactics for teaching-learning. In other words, the relationship between educators and learners, with ethical and humanitarian commitment, must permeate values of scientific thought. Education is, therefore, a central space in decision making while facing COVID-19. In this regard, we emphasise the need for a multidisciplinary development, involving the synergy between neurosciences and education.

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